Strategic Mobility 21

Integrated Tracking System Analysis and Concept Design

Contractor Report 0009; 0010; 0012

Prepared for:

Office of Naval Research
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14. ABSTRACT

Strategic Mobility 21 (SM21) is a Congressionally mandated and independently funded applied research program through the Dep't of Defense (Office of Naval Research), under the auspices of the California State University Long Beach Foundation, a government-industry academic collaborative enterprise. This design document supports the SM21 efforts in developing a dual-use multi-modal node at the Southern California Logistics Airport in Victorville, CA that will be supported by an Integrated Tracking System (ITS). This ITS design document identifies the technical and functional requirements for developing, procuring, & integrating components of an ITS capable of supporting an inland regional port, multi-modal operating software system. The design document supports the development, deployment, and testing of an ITS based on a Service Oriented Architecture (SOA) that will enable efficient node and individual terminal operations by: optimizing logistics flows; helping to maintain desired productivity; and providing high service quality to strengthen customer relationships through up to the minute visibility of shipments and quick turn times.

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September 13, 2007

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Subject: Deliverable Number 0009, 0010, & 0012, Integrated Tracking System Analysis and Concept Design

Reference: Strategic Mobility 21 Contract N00014-06-C-0060

Dear Paul,

In accordance with the requirements of referenced contract, we are pleased to submit this Integrated Tracking System Analysis and Concept Design Document for your review.

Your comments on this document are welcomed.

Regards,

Dr. Lawrence G. Mallon
Strategic Mobility 21 Program Manager

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ABSTRACT

Strategic Mobility 21 (SM21) is a Congressionally mandated and independently funded applied research program through the Department of Defense (Office of Naval Research). The program is conducted under the auspices of the California State University – Long Beach Foundation, a government-industry academic collaborative enterprise. This design document supports the SM21 efforts in developing a dual-use multi-modal node located at the Southern California Logistics Airport in Victorville, California that will be supported by an Integrated Tracking System (ITS). In the context of the SM21 program, dual-use technology is defined as serving both the commercial and military sectors. This ITS design document identifies the technical and functional requirements for developing, procuring, and integrating components of an ITS capable of supporting an inland regional port, multi-modal operating software system. It is not intended to identify all the systems that will compose the end state deployment of the SM21 developed ITS or multi-modal operating system. The design document supports the development, deployment, and testing of an ITS based on a Service Oriented Architecture (SOA) that will enable efficient node and individual terminal operations by: optimizing logistics flows; helping to maintain desired productivity; and providing high service quality to strengthen customer relationships through up to the minute visibility of shipments and quick turn times.

1.0 BACKGROUND

This document defines the design initial operating capabilities (IOC) for the Joint Deployment and Distribution Support Platform (JDDSP) Integrated Tracking System (ITS) that will support the flow of freight to and from the Southern California Logistics Airport (SCLA) located in Victorville, California. The ITS will be integrated with the Inland Port-Multi-Modal Terminal Operating System (IP-MTOPS)[1]. The design supports a stepwise (incremental) development and deployment effort that will lead to the IOC, as defined in this document, within a two year program period. This design concept integrates Contract Line Item Numbers (CLIN)[2] 0009 Joint Data Standard and Communications Protocol; CLIN 0010, the Regional Wireless Network Design; and CLIN 0012, the Regional IT Data Network, into a single product design - the JDDSP-ITS[3].

The ITS will support the dual-use[4] concepts defined in the Strategic Mobility 21 (SM21) Joint Operational Concept Document (JOCD) along with the initial operating capabilities defined in the SM21 Initial Capabilities Document (ICD). The SM21 Program Management Plan (PMP) with the Technical Plan Annex governed the development of this document.
SM21 is a program chartered by Congress to develop, demonstrate, and deploy the concepts embodied in the JOCD and ICD at the former George Air Force Base in Victorville, California. SM21 is working with the Southern California Logistics Airport Authority (SCLA), a public-private partnership, charged with development of the former DOD site for dual military and commercial use purposes.

The overall SM21-JDDSP architecture is a system-of-systems. The enterprise architecture is currently under study within several ongoing SM21 tasks and will incrementally evolve during the follow-on efforts. The ITS development described in this document is designed to evolve as one of the subordinate system-of-systems within the SM21-JDDSP enterprise architecture. Specifically, in the near term the ITS will support the prototype concept embodied in the IP-MTOPS more fully described within this document.

1.1 The Strategic Mobility 21 Objective and Mission

The ITS must support the SM21 objective, which is to integrate the physical components (system-of-systems) of an Agile Port System (APS) to support both commercial and military goods movement requirements within the Southern California regional context.

The physical components of an Agile Port System (APS) include:

1. An efficient marine terminal measured by its capability to accommodate both military and commercial goods movement with minimal disruption between one and another.

[1] The Inland Port Management Information System (IP-MTOPS) will be developed by the Strategic Mobility 21 program to support the Southern California Logistics Airport (SCLA) and the Joint Deployment and Distribution Support Platform as defined in the JDDSP Multi-Modal Terminal Software Specification.
[2] CLIN Titles are as provided in the Office of Naval Research provided Statement of Work.
[3] Hereafter in this document referred to as the ITS.
[4] The term dual-use refers to the use of the ITS by both the commercial and military sectors.

2. An inland staging area or transfer facility capable of performing most functions of a marine terminal except berth operations.
3. A dedicated surface transportation link such as short haul rail or dedicated truck lanes.
4. An information architecture integrating and synchronizing the operation of the other system components.

SM21 uses the APS, as defined by the Center for the Commercial Deployment of Transportation Technologies (CCDoTT), as the physical reference model for the JDDSP and the subordinate ITS. The SM21 program developed JDDSP at SCLA will specifically provide the:

- Integrating information management system for the dual-use APS and
- Physical support required for inland staging and transfer including most functions of a marine terminal except berth operations.

The JDDSP has been defined as a regional multi-modal and intermodal inland port but more specifically as a regional multi-modal logistics airport. The integrating information management system includes both the ITS and the IP-MTOPS as components within a Service Oriented Architecture (SOA).

1.2 ITS Development Approach and Team Members

The approach to be taken by SM21 with our selected team members during the development of the ITS development process can be described in simple terms: “Talk a little, model a little, learn a lot”. In order to enable this incremental development process we have established an initial list of stakeholders and team members to collaborate with SM21 on the discovery, development and deployment of the ITS initial operating capability.

In addition to the SM21 Team Members, government, academic, and industry partners will collaborate on the overall ITS development, testing, and demonstration. Major importers and exporters through Southern California will be designated to support the discovery and analysis associated with the identification and validation of commercial shipment requirements and will, as practical, participate in technology and process experimentation.

Dole Foods, the fifth largest importer through Southern California, will provide initial testing support for the ITS. The process will begin with the integration of the Dole U.S. Customs and Border Protection, Automated Manifest System (AMS) data with the SM21 incidence of the Trade Corridor Operating System (TCOS). The AMS data will be used to test the SM21 Experimental Database developed as a part of CLIN0009 and the Web Portal or IP-MTOPS interface described in more detailed in the following sections of this document. After the completion of the initial tests, and the deployment of the basic ITS system, Dole and SM21 will continue to evaluate capabilities required to fill the gaps in the Dole supply chain visibility and management systems.

In addition to Dole Foods, Rubbermaid, which currently operates a distribution center at the SCLA, will participate in experimentation more focused on the IP-MTOPS development. However, like Dole, Rubbermaid will also participate in experimentation related to closing the information gaps that exist within their regional supply chain visibility and management systems. The later experimentation will be a direct part of the ITS described in this document.

In addition to commercial partners, the ITS will support local, regional, state, and federal government agencies. The primary regional government participation will be with the Southern California Association of Governments (SCAG), a Metropolitan Planning Organization (MPO). Figure 1 below provides an overview of the geographical area of responsibility for SCAG.

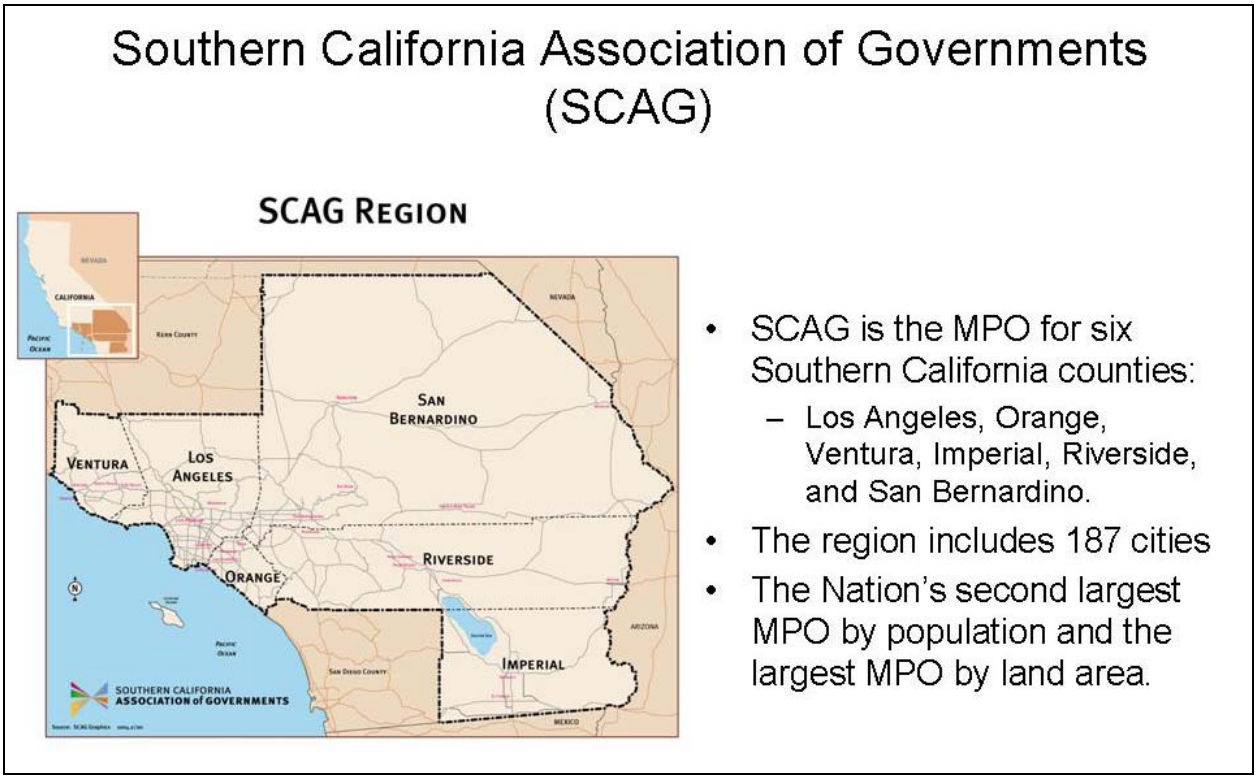


Figure 1: Southern California Association of Governments

At the federal level, both the Department of Defense and the Department of Transportation Maritime Administration (MARAD) will participate in early ITS testing. The initial comprehensive federal test and demonstration of the ITS capabilities is designed to demonstrate the use of the ITS in environments outside of Southern California. This test will be conducted with the US Transportation Command and the Port of Tacoma in the Pacific Northwest during a major military force deployment. The ITS initial operating capability will also support the joint SM21 and MARAD project designed to define and, as appropriate, develop and demonstrate an in-gate/out-gate appointment system. The approach for the MARAD sponsored project is to define the system architecture and the associated business practices and then deploy the system for limited testing within Southern California. As previously noted, a key component of this system will be the incorporation of the SM21 ITS.

1.3 The SM21 Operational View

Figure 2 below is the SM21 Enterprise Operational View-1, developed using the Department of Defense Architecture Framework (DoDAF), which was used as one of the frameworks for development of the SM21 enterprise architecture (EA). The OV-1 is a high level operational concept graphic and textual description of the SM21 operational concept.

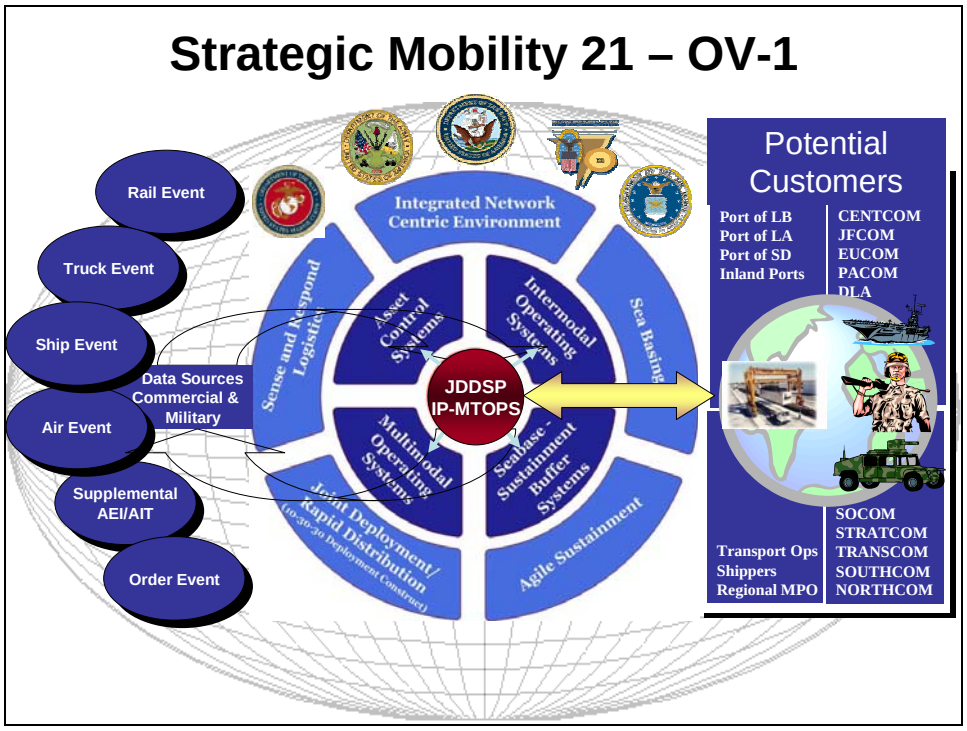


Figure 2: Strategic Mobility 21 Operational View 1

The ITS Operational View is further described in the OV-1A Diagram provided below in Figure 2. The ITS focuses on the integration of the event data represented by the blue ovals on the far left of the OV-1 Diagram and integrates this event data with the JDDSP IP-MTOPS represented by the red circle in the center of the OV-1 Diagram. The ITS event data requirements will be defined by the operational system requirements (dark blue inner ring surrounding the JDDSP IP-MTOPS) and the DoD capability concept represented by the lighter blue outer ring surrounding the IP-MTOPS. Additional, the JDDSP military and commercial potential customers depicted on the far right of the OV-1 Diagram define the overall JDDSP required capabilities.

2.0 ITS REFERENCE MODELS

The ITS developed will follow several reference models to develop the internal system-of-systems architecture:

- As a component in the SM21 EA systems-of-systems architecture, the ITS will reference the Federal Enterprise Architecture.
- The physical reference model, as previously described, is the CCDoTT Agile Port System
- The ITS system development will be guided by the OASIS Reference Model described within this section.

2.1 Federal Enterprise Architecture Reference Models

The SM21 Enterprise will use the Federal Enterprise Architecture (FEA) collection of interrelated "reference models" initially designed to facilitate cross-agency analysis and the identification of duplicative investments, gaps, and opportunities for collaboration within and across Federal Agencies. In the near term the FEA will not be referenced for the ITS initial operating capability; however, in working within the overall SM21 EA, the ITS effort will ultimately be guided by the FEA. A detailed description of the FEA can be found at the E-Gov Web page: http://www.whitehouse.gov/omb/egov/a-2-EAModelsNEW2.html.

2.2 Physical Reference Model – Agile Port System

The ITS will be follow the CCDoTT Agile Port System physical reference model as a part of the initial operating capability development. The first full test of the ITS will occur as a part of the demonstration of the Agile Port System in the Pacific Northwest. The Agile Port System was described in prior sections. The reference documentation is available on the CCDoTT Project Results Website within several files related to the Pacific Northwest Agile Port Analysis and Demonstration: http://www.ccdott.org/content/DS_fr.html.

2.3 Service Oriented Architecture Reference Model

The deployment of the ITS and the overall IP-MTOPS will employ a stepwise deployment process that will ensure early operating capability in the near term and in the long term a state of the art Service Oriented Architecture (SOA) framework. The SOA concept has received significant interest within the software design and development community, which has resulted in the proliferation of many conflicting definitions of SOA. To mitigate this problem, the SM21 program has selected a SOA reference model developed by OASIS (Organization for the Advancement of Structured Information Standards), a not-for-profit, international consortium that drives the development, convergence, and adoption of e-business standards. Whereas SOA architectural patterns (or *reference architectures*) may be developed to explain and underpin a generic design template supporting a specific SOA, a **reference model** is intended to provide an even higher level of commonality, with definitions that should apply to *all* SOA[5].

The selected reference model is an abstract **framework** for understanding significant relationships among the entities of the SCLA-JDDSP. It enables the development of a specific

[5] Reference Model for Service Oriented Architecture 1.0, Public Review Draft 1.0, OASIS, 10 Feb 2006, page 4

architecture using consistent standards or specifications supporting the SCLA-JDDSP Business Community. For additional background and model information, please refer to the complete reference model documentation, which is available at the SM21 PMIS or at http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=soa-rm.

The SM21 program goal for using this reference model is to define the central concepts of service oriented architecture, and establish a vocabulary and a common understanding of SOA for all program stakeholders both internal and external. It will provide a "normative reference" that will remain relevant throughout the SM21 SOA stepwise development and implementation, irrespective of the many future technology evolutions that will influence SOA deployment.

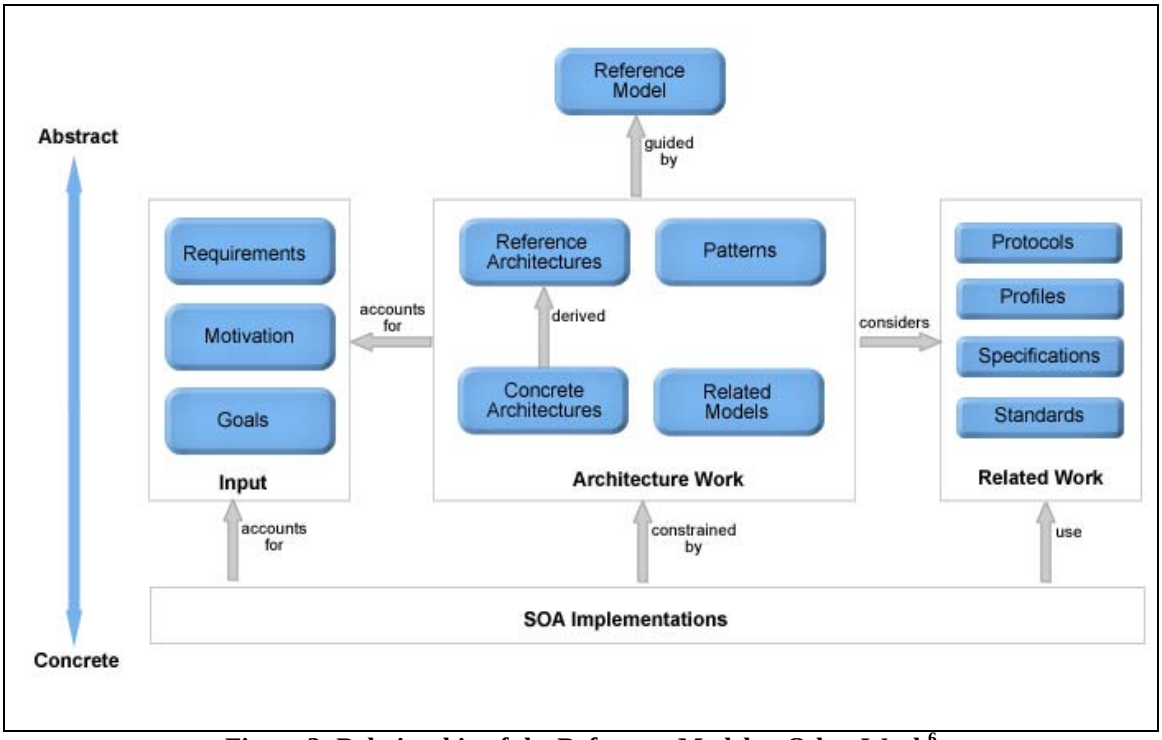


Figure 3: Relationship of the Reference Model to Other Work[6]

The concrete ITS and overall IP-MTOPS architecture will be developed using the requirements identified in this document. The SM21 supported ITS and IP-MTOPS Architecture development will not be done in isolation but will account for the goals, motivation, and requirements that define the actual problems or gaps being addressed in both the commercial and military sectors.

[6] Oasis Reference Model for Service Oriented Architecture 1.0, 10 February 2006; Figure 1, page 5

3.0 OVERVIEW OF THE ITS ANALYSIS AND CONCEPT DESIGN

This document focuses on the concepts and requirements for the ITS and the deployment of an initial operating capability depicted below in the SM21 OV-1A diagram. The SM21 JDDSP system of systems enterprise architecture, depicted above in the OV-1 Diagram (Figure 2), will be incrementally developed using existing commercial off the shelf (COTS) software and legacy DoD information management systems. The SM21 EA is designed to evolve into a Service Oriented Architecture (SOA). The ITS will be the first increment of the SM21 EA developed. As a subordinate component of the SM21 EA, the ITS will also be incrementally developed. The ITS will be developed and updated through the continuous integration of required event data from various forms of Automatic Identification and Data Capture (AIDC) technologies and data interchange formats and protocols.

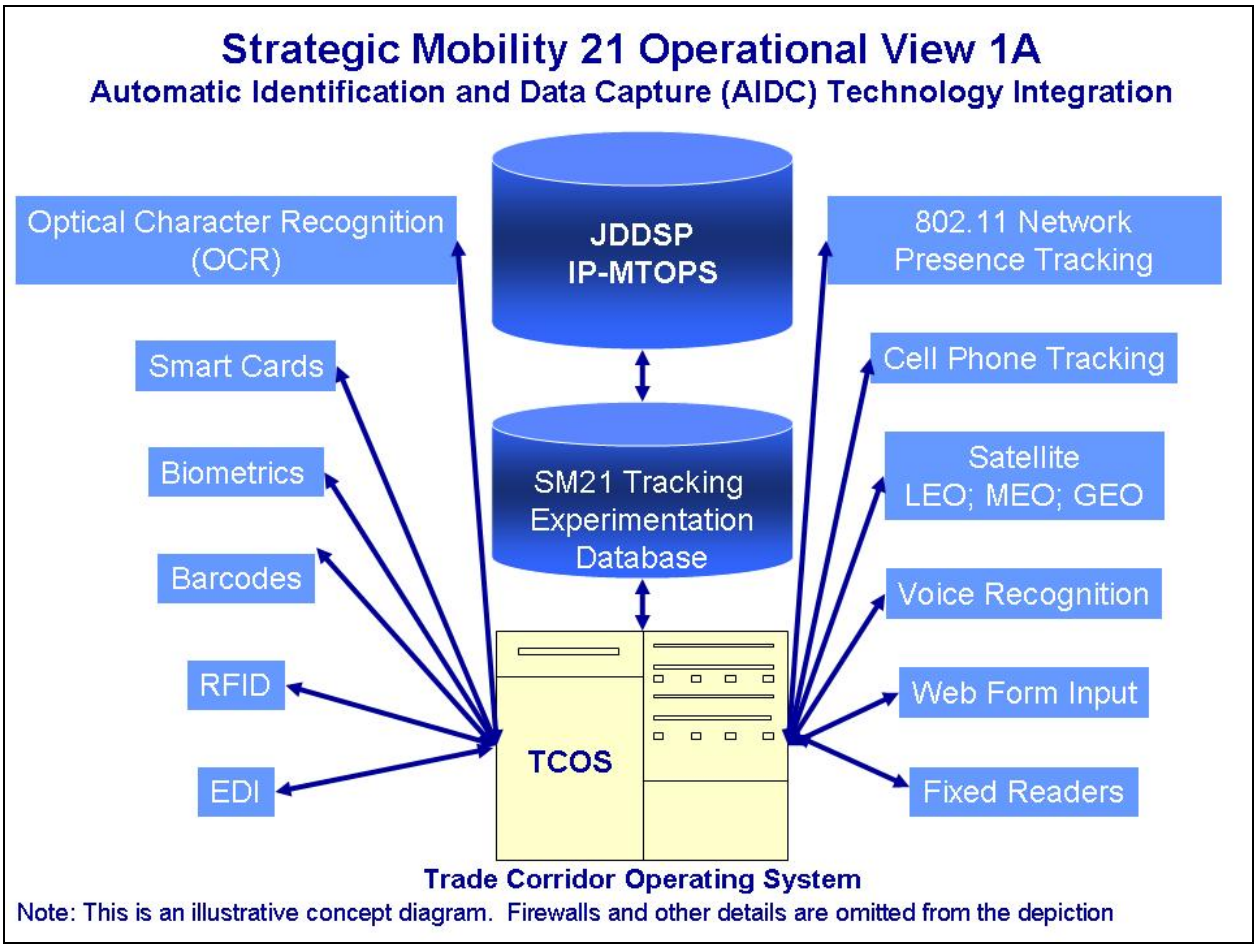


Figure 4: SM21 OV-1A Automatic Identification and Data Capture Technology Integration

Initially Dole Automated Manifest Data will be integrated. This initial event data integration will be followed by AIDC event data including RFID and bar codes but will be extensible to other technologies including biometrics, magnetic stripes, OCR, smart cards, cell phone tracking, 802.11 network presence tracking, and voice recognition. The SOA design, when fully implemented, will support the acquisition of information from AIDC readers, aggregation of the

information from disparate AIDC technologies, and the provisioning of common location-based logistics services including asset location and cargo tracking. In particular, a dual-use surface transportation asset and cargo tracking capability for tracking both transportation assets and individual cargo shipments will be studied. AIDC information should be available from users of the JDDSP, terminal tracking systems, and regional tracking systems and can be supplemented with information from other sources such as EDI and Web Form input. Figure 3 above depicts the initial flow of AIDC information through the ITS to the JDDSP IP-MTOPS. This configuration is only established for early testing and experimentation. The objective system deployment is depicted in Figure 7, the SM21 OV-1B View.

During the early testing of the ITS, the SM21 Tracking and Experimentation Database[7], developed by SM21 (CLIN009), will be employed and refined as required. The information processed through TCOS to the database will be accessed by IP-MTOPS. IP-MTOPS is currently in the early stages of design development.

In the typical case, items will be "identified" by their association with AIDC technologies such as RFID tags or bar codes. The identified items may be assets - including conveyances such as rail cars, tractors, and chassis - individual items of cargo, collections of items in either some form of packaging (box, pallet, etc.), or shipping containers. An association is made between the AIDC information and the item it identifies (often by using an AIDC reader to read the AIDC information associated with the item and then combining that information with an application-specific identification of the item) and this identification is stored in a dataset. Logistics systems then use the associations stored in systems such as IT-MTOPS along with reads reported by AIDC readers to facilitate valued-added services such as asset location, cargo tracking, ordering, shipping, and stock management. The key gap that the ITS design will fill is the integration of information from multiple sources of AIDC and EDI data.

This ITS study performed preliminary evaluations of active RFID tag-based technology developed by Savi. The Savi system is currently being used as a component of the Department of Defense's In Transit Visibility (ITV) System and will provide input to the ITS. While SAVI tag readers, SAVI tag programmers, and the DoD ITV system will be sources of data for the ITS, other selected RFID technology has been reviewed for specific uses. The other systems reviewed include WhereNet and TransCore wireless technology. All three currently have operating applications in the Southern California Region that will directly or indirectly provide information to the ITS through the Trade Corridor Operating System (TCOS) developed by TransCore. TCOS will enable the capture of information from various RFID tags and other tracking systems. TCOS is described in more detail within this document.

Figure 4 below provides the UML class model illustrating the key AIDC tracking concepts in end-state or full operating capability (FOC of the SM21 ITS).

[7] The database design is document in the SM21 CLIN0009 Report, "Development of Joint Data Standards and Communication Protocols in An Integration Container Tracking System," March 15, 2007

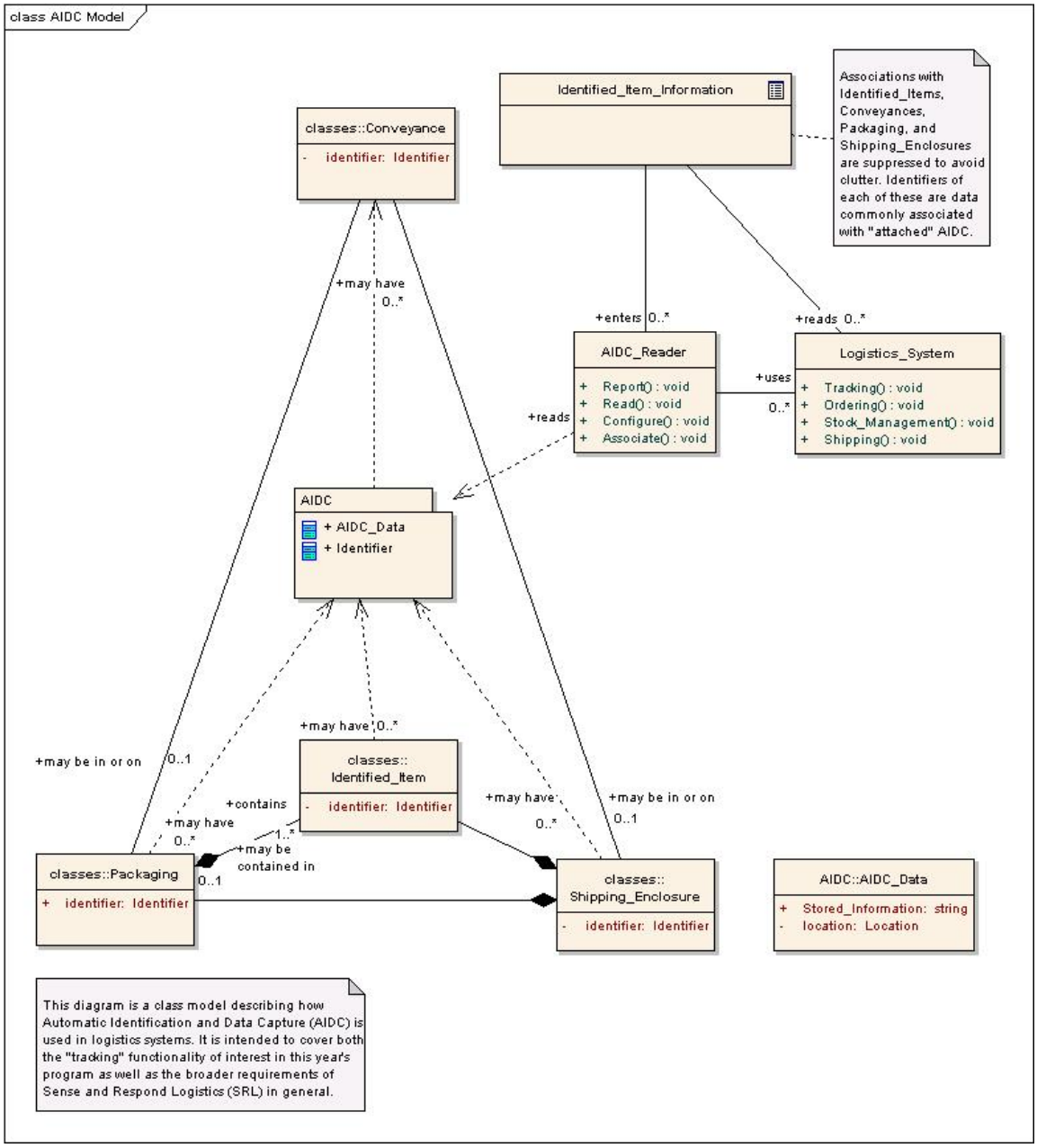


Figure 5: SM21 AIDC Class Model

The expected benefits of the integration of AIDC to the ITS are outlined in Table 1 below.

Expected Benefits of the Integrated Tracking	
Stakeholder	**Expected Benefit**
Shippers/Consignees	Pickup/delivery notification Improved accuracy of logistics information Container and truck location at key points
Ocean and Rail Carriers	Pickup/delivery notification Improved accuracy of logistics information Enhanced customer service
Freight Forwarders/Brokers	Reduced paperwork Improved communication with Customs Reduced cost due to improved truck operations
Terminal Operators	Increased gate moves/throughput Pre-notification of truck arrival More efficient use of labor/equipment Enhanced customer service Reduced paperwork
Truck Drivers	Reduced wait times at border and port terminals Fuel savings from reductions in wait times Increased capacity for additional moves Reduced paperwork
Regional Transportation Agencies	Improved planning for freight transportation Increase in commercial vehicle safety
U.S. Customs/U.S. and Mexican Governments	Improved security through E-Seal verification Improved security through truck tracking Improved throughput of trucks at border crossing Reduced paperwork
Customers	Improved tracking and visibility of cargo Improved ability to support just-in-time logistics Lower costs (efficiency improvements)

Table 1: Expected Benefits of the Integrated Tracking System

3.1 ITS Initial Operating Capability Deployment and Testing

As depicted in Figure 3, the initial testing of the ITS and SM21 Tracking and Experimentation Database (data repository) will employ TCOS feeding input directly to the SM21 Experimental Database. This initial testing environment will be supplemented by the deployment of the IntelliTrans-TransCore suite of systems.

In open sources a significant number of experienced SOA developers have two words of advice: Start small or as stated earlier talk a little, model a little, learn a lot. Incremental change and gradual improvements will be employed rather than developing the objective system without first developing and deploying small focused capabilities. In the case of the ITS, the first deployment will integrate business and IT strategies to provide Dole with common services that leverage existing and limited new functionality. To achieve success, the ITS development will start with the TCOS system and the integration of the Dole Foods provided AMS data, a project with future business value. Throughout the first year of capability deployment, the ITS project will be tightly focus on continuing to evolve the Dole supply chain tracking services. The aim is to start off with a few key SOA pieces without trying to initially develop the objective environment. Following the initial data integration, the second stage deployment will begin, which involves testing the SM21 developed Experimental Database (CLIN0009). Subsequent to a successful test, the project will begin the iterative talk a little, model a little, learn a lot process until the Dole Food and SM21 Team can declare “success”.

3.1.1 Commercial Off-the-Shelf System Integration

The ITS and IP-MTOPS systems will be heavily dependent on COTS and Government legacy applications, which includes mode and terminal operator owned systems and SM21 partner systems, primarily those of IntelliTrans-TransCore, CDM (ICODES and TRANSWAY), and to a lesser degree SAVI-Lockheed Martin. The IntelliTrans-TransCore, CDM, and SAVI suites of systems have been tested in both commercial and government service thereby uniquely enabling SM21 to accelerate the development of an initial operating capability based in a public-private partnership role.

The initial focus will be the deployment of the TransCore 3sixty application, a complete shipment and asset management operating system, which is capable of supporting military and commercial shipments through Southern California. Using 3sixty as the basic operating system, SM21will deploy the required backbone for the development and execution of a comprehensive experimentation program during the follow-on program effort starting in September 2007.

The strategy for deploying 3sixty is to develop a well defined and detailed project plan within the first two weeks of contract award that will establish the deployment timetable. The program will be managed by a dedicated IntelliTrans project manager. The immediate development of the project plan will support the rapid deployment of the required SM21 initial operating capability. This initial capability deployment to support and operate an Integrated Tracking System will employ existing COTS solutions that will require minimal development and customization.

Using 3sixty and ICODES for the support backbone, SM21 will complete an experimentation program that leverages coordination previously conducted with USTRANSCOM for a military

force deployment demonstration in the Pacific Northwest, as well as the Dole Foods commercial container shipment optimization studies. The SM21 support efforts related to the Green Freight Corridor Network will be greatly benefited by the early deployment of the initial ITS capabilities.

The experiments and Green Freight Corridor Network development will assist in the evaluation of hypotheses, JDDSP concept refinement, and achieving substantive objectives established by both commercial and government entities. The effort will include supporting the integration of TRANSWAY, ICODES, and AALPS into 3sixty and the experimentation plan. This will assist SM21 in the development of the specifications for a combined commercial and government movement common operating picture.

As the basic operating capability for the initial ITS, 3sixty will facilitate experimentation and drive the JDDSP concept to an initial operating capability (IOC). The core premise for this deployment is to provide SM21 with a flexible suite of products that delivers the information and services needed for customers to make their transportation enterprise as efficient and profitable as possible. The 3sixty suite of products and services selected for deployment will provide a variety of operations management tools that will be employed to run the ITS and ultimately the JDDSP.

These tools include:

- TCOS – Trade Corridor Operating System – the initial ITS application to be deployed
- Global Visibility Platform – multi modal asset and shipment tracking, to include a yard management system
- An integrated service application composed of six (6) core services:
  - Freight Match Services
  - Fleet Management
  - Operations Management
  - Compliance Services
  - Financial Services
  - Rail-Intermodal Services (including track and trace).

In addition to the applications outlined above, a variety of technical solutions to support experimentation for the JDDSP will be employed. This includes AEI tags and readers for the rail and intermodal network, RFID tags for trucks, trailers and containers, and GPS units for ubiquitous visibility.

The following sections provide more detailed information on the ITS initial system architecture components.

3.1.2 Trade Corridor Operating System

This section of the document provides a description of the fundamental characteristics of Trade Corridor Operations System (TCOS) and its applicability to the ITS and IP-MTOPS.

3.1.2.1 Background and Applicability to ITS-Agile Port System Demonstration

TCOS is a system of hardware and software that was developed by TransCore originally for the Washington State Department of Transportation (WSDOT) to implement the Northwest International Trade Corridor and Border Crossing System (NWITC). The NWITC is an operational secure freight management pilot program managed by the WSDOT Intelligent Transportation Systems (ITS) office. The ports of Seattle (American President Lines (APL)) and Tacoma (Maersk-Sealand) are integrated into the system along with the Washington State Commercial Vehicle Information Systems and Networks (CVISN) weigh stations and commercial vehicle database. These sites are outfitted with roadside Automatic Vehicle Identification (AVI) sensors (to read CVISN Radio Frequency Identification (RFID) vehicle tags) and other RFID sensors for reading electronic container seals (e-seals) and Free And Secure Trade (FAST) compatible vehicle sticker tags and driver/crew ID cards. The US Department of Homeland Security bureau of Customs and Border Protection (DHS CBP) commercial vehicle processing facility at Blaine (at the Washington border with Canada) is also instrumented with AVI, e-seal and FAST RFID sensors. This integrated secure freight management system monitors the movement of freight transactions moving north and south along Interstate 5, between Seattle/Tacoma and Vancouver, BC, Canada.

The Pacific Northwest TCOS deployment will significantly reduce the risk of the SM21 support to the PNW Agile Port System (APS) force deployment demonstration. While some of the initial ITS testing will be completed in Southern California, the first near full operating capability test in an actual deployment will occur in the PNW. A phased demonstration build-up process will be established as part of the APS demonstration plan to further mitigate risk.

3.1.2.2 TCOS Functional Design – Web Service

TCOS includes both site sensor controller hardware and software, and regional data center hardware and software. The site controllers all share a common set of software that is uniquely configured for each site. The site controllers are responsible for interfacing with sensor hardware, buffering sensor hardware status and RFID read events, and reporting to the TCOS data center (via a secure Internet connection). The data center receives reports from all of the site controllers in near real time. The reported status and events are processed and stored in a database. The TCOS web server provides real time access to this information to authorized users on the Internet via a secure website (www.transcorridor.com). TCOS also receives and distributes event reports from other sources such as the seaports and weigh stations via their respective information management systems (IMS). Near real time interfaces supported by TCOS include: email and cellular phone paging alerts to stakeholders and enforcement agents; TCP/IP Socket, FTP, SOAP, eForward, and other Internet-based interfaces with stakeholder IMS; and direct interfaces to the CBP Automated Manifest System (AMS).

3.1.2.3 TCOS Deployability

Although developed originally for NWITC, TCOS is a flexible baseline freight management system that can be adapted by SM21 to other regions. TransCore, and SM21 by extension, has been granted permission by WSDOT to utilize TCOS for such projects. TCOS has been successfully adapted for three trade lanes (two with BVSG/TransCore and one with SAIC/Savi) in the Operation Safe Commerce (OSC) project, and it is being extended to cover US

Department of Agriculture (USDA) Agricultural Inspection Policy and Programs (AIPP) trade lanes. TCOS will be configured by the SM21 team to include new sensor sites using the existing TCOS data center at TransCore in San Diego, California. If necessary (for security or other reasons), the TCOS data center software can be cloned and modified to support other trade lanes and/or other freight management projects on other server hardware and/or at other physical locations for the DoD. The TCOS-ITS application will include commercial vehicle trucks along with marine and rail transportation elements. The software architecture of the SM21 ITS TCOS deployment (in the data center and the site controller components) will enable rapid development and integration of software drivers for interfaces to new sensor types and new communication protocols for interfaces to other systems for testing, experimentation and deployment.

3.1.2.4 TCOS Adaptability Considerations

The TCOS software configuration within the SM21 ITS will enable the adaptation of the SM21 products to a variety of dual-use freight management system projects. The fundamental architecture provides a core of common code that will enable SM21 to provide both basic and industry-specific features consistently for all SM21 ITS application modules. This core includes everything form high-resolution event timing to various forms of communication to diagnostic logging to event correlation. Basic higher-level TCOS application modules provide coordinated event logging, homogenized external device connections, sensor and output device drivers, and generic site controllers and data center functions.

The SM21-ITS TCOS supported application modules communicate using a common messaging interface via TCP/IP (the low-level protocol of computer networks - including the Internet). This TCOS language (a simplified and more flexible derivative of XML) will allow SM21 ITS modules to be distributed in a variety of ways using simple configuration file settings. Multiple modules will be run on the same computer, on different computers across a local area network, across the world via the Internet, or any combination without changing any code. The SM21 ITS TCOS application will employ dynamic programming languages to enable modules to run on different computer operating systems without code changes. The TCOS language is human readable and it can be extended to message passing via slower interfaces such as email, website forms, and interactive human text messaging sessions.

The TCP/IP connection protocols in the SM21 ITS-TCOS application modules will be made more flexible by having each module a multiple simultaneous user server as well as a potential client to multiple other TCOS modules. A primary design feature will enable fast configuration of complex networks that will also allow human users to monitor the activities of any SM21 ITS-TCOS application module without disrupting its normal operation (accelerating development, configuration, testing, diagnostics, and maintenance).

The extensive use of dynamic languages will enable SM21 to rapidly develop new features and entire new modules for the SM21 ITS-TCOS as needed to implement the requirements of the ITS in other regions and deployment scenarios. The standardization of module-to-module communications means that such features do not need to be reengineered, and new connections between modules are very straightforward (very little redesigning required to accommodate new modules in the SM21 ITS-TCOS network).

The TCOS communication language is defined using object-oriented configuration files that serve to efficiently implement a great deal of the TCOS applications, as well as simultaneously implementing the system interface documentation (built in to the client interfaces as online interactive text, and also accessible via a web browser for dynamic interactive navigation). This arrangement means that the system interface documentation is never out of synch with the actual products because both come from exactly the same source.

3.1.2.5 SM21 ITS-TCOS Capabilities

TCOS implements five (5) major functions that are all applicable to multiple ITS projects such as NWITC, OSC and others. These are significant functions that are not easily developed from scratch. The SM21 ITS-TCOS will be deployable stand-alone as the IMS data center for a project, or the design will enable the interface with a higher-level IMS. Higher-level IMS do not typically support the lower-level TCOS functions, so TCOS bridges the gap between site sensors and other IMS and analysis tools. Frequently the higher-level systems and tools require access to proprietary and Security Sensitive Information (SSI) that needs to be protected. The SM21 ITS-TCOS deployments will be able to serve securely, and with low risk in such environments, as a gateway - by using index values for data. Highly secured IMS can use the index values reported by the SM21 ITS-TCOS to reference the protected information. Using TCOS rather than developing lower-level interfaces for other IMS leverages the maturity already invested in TCOS. TCOS first went operational for NWITC in 1999 and has been continuously maintained, updated, and improved. The current architecture of TCOS has been running continuously in the NWITC since June of 2002 - processing hundreds of transactions per day. Dramatically enhanced TCOS software has been tested and will be deployed with the SM21 ITS-TCOS data center hardware.

3.1.2.6 Major Functions SM21 ITS-TCOS

1 - Data Acquisition:

The sensor site controller components of the SM21 ITS-TCOS will interface with various RFID readers and other sensors and/or output devices (such as driver signals, active barriers and variable message signs) to monitor hardware status and to acquire events (such as tag reads). These status and event records will be time and date stamped, correlated with each other, associated with the site, and buffered. Event records will be reported in real time or in batch (on a periodic/timed schedule) to the SM21 ITS-TCOS central data center, local IMS, and/or to a SM21 ITS-TCOS regional data center. The site controller will also be configured as a server so a data center can actively retrieve buffered data from the site instead of having the site actively send data to the data center. The default will be for the sites to actively connect to the SM21 ITS-TCOS central data center and send event data and hardware status changes in real time (as soon as it is detected). A separate configuration option will have the site report its current status periodically - so the data center will know that the site is still functioning - even if it has nothing new to report. For data redundancy and system diagnostics, site controllers will also be configured to log events, status, and other site activity to local hard drives.

2 - Data Collection

The first function of a SM21 ITS-TCOS data center will be to collect the status and event reports from all of the sensor site controllers and record them in a central database. The application will collect this kind of data from other external sources (such as other IMS described in this

document) when the sensors are not integral components of TCOS. This data can be received in real time or in batch. The site controllers will feature buffering, to allow the SM21 ITS-TCOS data center to go down for extended periods of time without losing status and event data. Since the site controllers will all time and date stamp all records, batch reports will still be put into the database correctly. The SM21 ITS-TCOS will receive data from handheld readers when docked to an Internet-connected computer, or event data will be entered manually into the SM21 ITS-TCOS via either email or a website form.

3 – Regional Data Sources

Extensive research was conducted on the sources of regional tracking data outside of customer and transportation mode and terminal operators. The regional tracking area is defined by the geographic area of responsibility for SCAG as overviewed in Figure 1. Throughout the region significant investment in ITS technologies has been and continues to be used to help increase the efficient management of the transportation networks. ITS applications provide the region with key management tools that help the operational efficiency of the transportation network. ITS applications also contribute to security and safety. The greatest challenges and perhaps the greatest benefits lie in integrating major systems across the entire region. The SM21-ITS will help to overcome some of the challenges and provide the region will additional value add for its investment in sensor and ITS technology. The recently documented Southern California Regional ITS Architecture document is a primary reference for the sources of ITS event data within the region.[8] Currently the region's freeway networks are equipped with the following:

- Vehicle Detection Stations (VDS),
- Closed-Circuit Television (CCTV) cameras,
- Changeable Message Signs (CMS),
- Ramp Meter Stations (RMS),
- Highway Advisory Radio (HAR), and
- Environmental Sensor Stations (also known as road weather information systems (RWIS))

The ITS field elements are connected to the Regional Caltrans Transportation Management Centers (TMCs) depicted in Figure 5 below.

[8] Southern California Regional ITS Architecture, NET, Final Version 6.0, April 2005

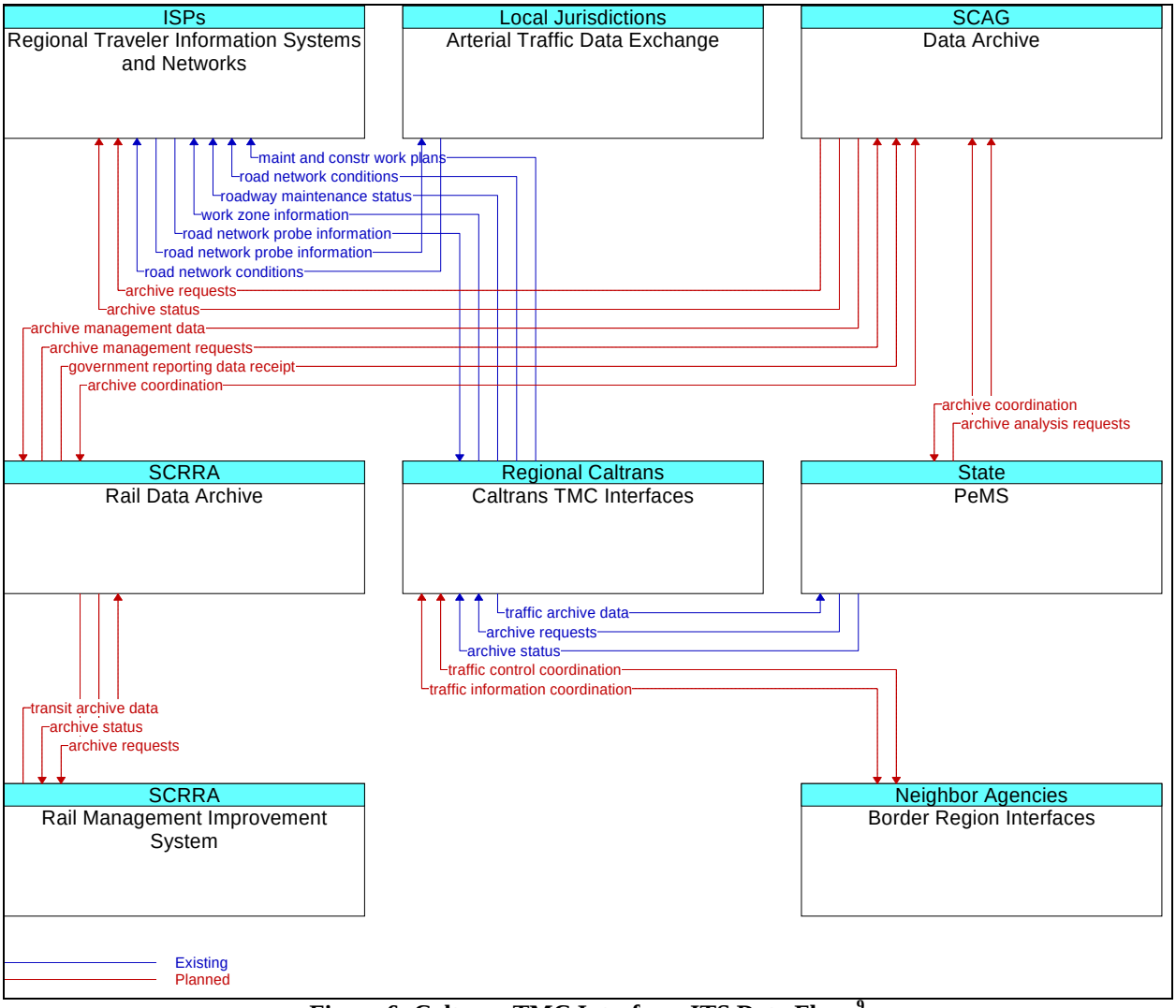


Figure 6: Caltrans TMC Interfaces ITS Data Flows[9]

The Freeway Performance Measurement System (PeMS) included in Figure 5 is a consolidated database of information collected via Caltrans loop detectors and provided as a Web Service by Caltrans through the University of California, Berkley. The intent is to work with SCAG and Caltrans to integrate selected ITS data flows defined in Figure 5 with the SM21 ITS.

4 - Data Processing

The SM21 ITS-TCOS will be able to both store raw site status and event records and apply logical processing to the data. The system will be capable of automatically evaluating status and event reports to check for security status, route compliance, travel time compliance, geographical boundary compliance (geo-fencing), authorized transaction component correlation consistency, credentials, and membership in targeting lists.

[9] Southern California Regional ITS Architecture, NET, Final Version 6.0, April 2005

When events are reported from multiple sensors at the same site, those records are often related to each other and will need to be combined into a singe composite event. This correlation can be done in the site controller, but the SM21 ITS-TCOS will the correlation to be completed in the SM21 ITS-TCOS data center so that the code can be managed in a single place. When events reported by different sites and/or other IMS require correlation, the correlation function will be performed by the SM21 ITS-TCOS data center.

Another form of correlation that the SM21 ITS-TCOS will perform is the evaluation of event data relative to prior detections of the same transaction item. This will include measuring travel time between sites and comparing that to allowable tolerances. This also involves monitoring where transaction components change associations (seal-to-container, container-to vehicle, driver-to-vehicle, etc.), and/or security status (sealed or tampered). Travel time checks between gateways in a trade lane rout are a critical component in building a secure freight management system.

The SM21 ITS-TCOS will also check event data against credential criteria and targeting lists (specified by authorized agents) to generate alerts. Another data collection capability of the SM21 ITS-TCOS will be the retrieval and/or receipt from other IMS: enrolments, registrations, credentials, filings, and other such information that may be needed to make these data processing decisions.

5 - Data Distribution

The SM21 ITS-TCOS will distribute its database information in various forms to multiple authorized recipients. Authorized human users will access real time system status and event data tailored for them using the SM21 ITS-TCOS web portal. Targeting will be set to generate alert reports via email to other IMS or to authorized human agents (via email or cellular phone text paging/messaging) when certain types of events occur. Other Internet-based protocols can be used to exchange data with other IMS. As required, non Internet-based communication channels will be used (such as the TCOS to DHS CBP AMS interface). New protocols will be adapted to the SM211 ITS-TCOS to interface with new IMS, or a standard protocol that TCOS already supports can be selected (such as EDI or XML).

6 - System Maintenance

An SM21 ITS-TCOS priority will be system maintenance functions. First, all sensor sites will report their hardware status to the data center whenever their status changes -and periodically. Therefore, the data center database will maintain a log of the history as well as the current status of all sensor site hardware. This information will be available on the SM21 ITS-TCOS website to all authorized users. The system database will also monitor when it has not heard from a site in its expected reporting period and will mark the site as reporting late (a probable sign of trouble). The SM21 ITS-TCOS database will also mark all other data sources (such as external IMS) if they do not communicate within a configurable time period.

Monitoring site status is not sufficient to support maintenance and the SM21 required level of service for government services, especially when the sensor sites are far away from service technicians. The SM21 ITS-TCOS sensor site controllers will all support optional dial-in auto-answer telephone modems for direct secure access to the operating systems (telnet and ftp). In

addition, the SM21 ITS-TCOS site to data center connection through the Internet will support a protocol that will allow a maintenance user to access the site system via a mutual connection to the data center (secure tunneling).

The SM21 ITS-TCOS applications will all be designed to allow direct monitoring by maintenance users. This means that a technician or programmer will be able to log on to any software component of TCOS and observe what is going on inside without disturbing its normal operation. This feature will flow as far down as the serial port interface level, to enable a maintenance person to diagnose problems down to the raw device interface. All of this will be done remotely from anywhere in the world via the Internet or direct-dial connection. This makes the basic assumption that either the Internet or the modem connection is available and working. However, the inherent maintenance features of the SM21 ITS-TCOS will save time and travel in most cases. In other cases, the SM21 ITS-TCOS remote maintenance capabilities will allow an engineer to guide a local technician to fix problems using a voice telephone and an Internet and/or direct dial-up connection.

3.1.3 SM21 Global Visibility Platform Deployment

To take advantage of the SM21 ITS-TCOS data, a wide array of software tools will be incorporated (including the IntelliTrans' developed ***Global Visibility Platform***, or ***GVP***), which will be deployed as modules. The following are the modules to be deployed within the follow-on program year:

- ***Multi-Modal In-Transit Visibility, and Intervention Services:*** These services include a collection of software tools built around a Multi-Modal Tracking System (MMTS) module for tracking and tracing shipments regardless of mode. The MMTS tracking modules will include:
    - Rail.
    - Truck.
    - Ocean Vessel.
    - Intermodal.
    - Barge.
- ***Rail/Intermodal RFID Solutions:*** This includes RFID solutions to the bulk distribution network, including reads from railcar AEI tags, and the integration of other RFID tags.
- ***Telematics:*** The system will be capable of providing telematics services through the appropriate deployment of the TransCore *GlobalWave*® and other appropriate solutions. This type of deployment will tie GPS and sensor data transmission into a single point of contact for hardware, software and services, enabling improved visibility including:
    - Load/empty detection.
    - Detection of valve, hatch, or dome conditions (open or closed).
    - Measurement of pressure, temperature, or other continuous parameters in real time and the generation of alarms.

- ***Rail Yard Management with RFID Solutions:*** The yard management module will provide a complete solution that is capable of providing visibility and command and control to multiple rail yards on a global basis. By integrating a combination of fixed and handheld AEI Tag Readers as well as human input, SM21 will be able to create an efficient yard management solution to support the workflow of rail yards.

  Some of the system functions will include the generation of:

  - Event Reports.
  - Switch Lists.
  - Digital Interactive Maps.
  - Detention with user defined rules.
  - Track Lists.
  - Yard Summary Report.
  - Tank Car Loader with Outage Tables.
  - Complex back end logic to control user actions based on circumstances.
  - Audit capability.

- ***Fleet Management Module*** for administering the maintenance, lease and contractual aspects of SM21 supported railcar fleets. This module will provide users date-range based search capabilities on rail assets including:

  - HM201 tests.
  - Tank tests.
  - Air brake tests.
  - Coil tests.
  - Rule 88b tests.
  - Out of service.
  - Requiring repairs.

- ***Empty Car Management Module:*** The Empty Car Management module will provide an empty & loaded railcar visibility tool coupled with a diversion decision support system and a railcar demand forecast system specifically designed to allocate railcars and will be designed to promote network optimization.

- ***Global Vendor Managed Inventory ("GVMI") Module*** for enabling optimal mode selection and will be designed to reduce working capital. The GVMI module will employ sensor and telemetry equipment to obtain and broadcast fixed-asset inventory levels. SM21 will work with RFID suppliers to provide Vendor Managed Inventory (VMI) capability on packaged goods, such as totes, cylinders and pallets.

- ***BEAM™ Metrics & Key Performance Indicator ("KPI") Module*** for will be deployed by SM21 to analyze distribution chain performance and will be capable of creating dashboards for monitoring distribution chain performance. The application will support the build of pivot tables and graphical metrics to support the improvement of service level and cost reduction. The KPI module will be linked to an email engine the will "push" KPIs to users on a scheduled basis.
- ***A Bill of Lading (BOL) Generator Module*** will be integrated into the shipment management platform and connected via EDI to all major railroads providing a common BOL platform regardless of carrier. Users will be able to build BOL templates based upon consignee, carrier, commodity, and equipment type allowing for custom formats in an efficient, automated environment.
- ***Detention & Demurrage Management Module:*** This module will enable the management of all aspects of the railcar detention and demurrage process to reduce costs, and verify the accuracy of demurrage invoices and determine the potential dollars that might be anticipated as detention revenue based on both current and historical shipment information.
- ***Rateables and Payables Module:*** The SM21 GVP deployed platform will offer users the ability to store rate and route information for all modes. A freight payables module will be built on top the SM21 database and will match the rate data to shipments and will have the capability to authorize and track payment information.
- ***Switch Performance Reporting:*** The Switch Performance Module will monitor railroad performance and ensure railroads are fulfilling their switch obligations at specific locations.
- ***Materials Management System ("M2S")***: This module will enable the management of operations controlling bulk inventory transload facilities.

SM21 will also employ a combined suite of transportation management services and solutions under the umbrella of the TransCore ***3sixty*** Transportation Management Services, which includes the Global Visibility Platform (GVP). In addition to the services listed above, the SM21 **3sixty** deployment will also include:

- ***Freight Matching Services:*** This service will enable users to ensure their loads are covered by extending connectivity to the 18,000 brokers and carriers that utilize this service.
- ***Fleet Compliance Services:*** This will include the management of fuel tax reporting, titling and equipment compliance, and tools to help users stay current on the latest U.S. Customs and Border Protection Regulations, including the Automated Commercial Environment (ACE).
- ***Wireless Fleet Management Services:*** The deployment of this capability will range from RFID-based systems for freight terminal gate access control to state-of-the-art GPS communications enabling better oversight of equipment location and status.
- ***Operations Management Services:*** The deployment will combine the services of two modules providing brokerage management solutions, including order management, accounts receivable, accounts payable, analysis reports, general ledger interfacing, and EDI data transmission with rating, tendering, scheduling, and in-transit visibility of shipments.

- ***Financial Management Services:*** This module includes fuel cost management, factoring, credit reporting, rate indexing, and assurance services.

3.2 Future ITS Development and Integration with IP-MTOPS

The integrated systems will be tested, redesigned or replaced as appropriate by more effective modules to support the designed stepwise (incrementally) deployment of a Service Oriented Architecture based Inland Port Multi-Modal Terminal Operating System (IP-MTOPS)[10]. The IP-MTOPS requirements are documented in an SM21 developed specification. As noted in the specification, no one single commercial software system will meet all the technical and functional requirements defined in the specification. Some or all of the systems tested as part of the IOC testing of the SM21 ITS will be deployed within the IP-MTOPS environment. Other systems and services will be procured and implemented by the individual tenants such as air cargo and intermodal rail terminal operators. However, as required, SM21 will also support the selection, or limited development, of systems capable of filling identified military and commercial support gaps and to:

- Enable efficient terminal operations in support of commercial and military shipments by *optimizing* logistics flows,
- Help maintain desired individual terminal and collective inland port *productivity*
- Maintain high customer service *quality*,
- Strengthen customer relationships through up to the minute *visibility* of shipments and quick shipment processing times.

The future development of the ITS and integration with the IP-MTOPS is overviewed in Section 5.0.

[10] The Inland Port Management Information System (IP-MTOPS) will be developed by the Strategic Mobility 21 program to support the Southern California Logistics Airport (SCLA) and the Joint Power Projection Platform as defined within this document and supporting SM21 documentation.

4.0 INTEGRATED TRACKING SYSTEM TESTING AND EXPERIMENTATION

As the capabilities are deployed and tested, appropriate experimentation will begin. The deployment of capabilities required to conduct the Dole Food supply chain studies and APS PNW force deployment demonstration will be deployed and tested first. Several smaller tests of the required integrated modules will be conducted in both Southern California and in the PNW.

The complete deployment process and experimentation plan will be documented in a project management plan to be completed within the first two weeks of the follow-on program year after all appropriate team member contracts are in place.

4.1 SM21 Tracking Experimentation Database

As an early objective, the SM21 Tracking Experimentation Database, as depicted in Figure 3, will undergo initial operational testing before deployment to a beta production environment. The database has been incrementally developed over several years and during the current project period of performance as CLIN0009.

The JDDSP requires an ITS that is based on integrated data standards and standard communication protocols. The ITS must have the ability to support improved goods movement and provide effective decision support for full spectrum military surge deployment, sustainment, redeployment, and reset operations. The JDDSP conceptual system architecture will be composed of layers including: a data capture and integration layer; a mediation layer; and an information interfacing layer to perform Extraction, Transformation, and Loading (ETL) processes. The ETL processes allow the raw data to be converted to useful information for both commercial and military shipment management.

Accordingly, using data and data flows to represent the physical movement and key control elements in the shipment tracking system, we seek to define the Information Technology (IT) architecture required to capture the major attributes and associated data elements in the area of shipment tracking. Tracking data required by the JDDSP includes commercial and military Electronic Data Interchange (EDI) segments; Car Location Messages (CLM); Auto Equipment Identification (AEI) technology; Radio Frequency Identification (RFID) tags; and sensor readers to track containers and equipment moving to and through the JDDSP.

The development of the JDDSP-ITS will start with building an integrated database, configuring secure data capture and integration networks, creating the information interfacing layer and ending with a web demonstration through the IP-MTOPS Web Portal.

4.2 Joint Data Standards, Communication Protocol, and Database Objectives

To develop joint data standards and communication protocols in the ITS, we set the following objectives to focus development and ultimately support stakeholders. The objectives will be used as a start point for the development of the ITS test plan:

- A collaborative community of interest comprised of military and commercial logistics planning managers (i.e., shipper activity planners, rail planners, truck planners,

intermediate node planners, marine terminal planners, vessel load planners, and end users);

- An automated and secure data center with multi-tier networks, server process, domain name controller, firewall routers, SQL/Oracle databases, backup/recovery plans, and various ETL programs;
- A strategic and operational logistics data standards and communication protocol which can be used to track vessel manifest, rail waybill, throughput velocity, equipment security, and shipping synchronicity of container and military equipment movement; and
- All shippers and regional Distribution Centers to have instant visibility of container and equipment shipments which can enable timely supply chain distribution and force deployment decisions using XML internet from everywhere in the world.

4.3 ITS Test Plan Development

An initial task during the follow-on period of performance will be the development of the ITS test plan based on the integration of the Dole Foods AMS EDI data, TCOS, the SM21 Tracking Experimentation Database, using the beta IP-MTOPS web interface.

5.0 INLAND PORT MULTI-MODAL TERMINAL OPERATING SYSTEM (IP-MTOPS)

The Inland Port Multi-Modal Terminal Operating System (IP-MTOPS) will manage the exchange of structured and unstructured data provided by the SM21 ITS- and other freight and asset management software systems employed for moving freight into, out of, and within the SCLA. Collectively these external and internal facility/information systems will provide the information necessary for the IP-MTOPS to perform the manipulation, temporary storage, retrieval, transmission and presentation of actionable information. The primary IP-MTOPS function will be to provide timely, actionable data needed by decision makers to manage terminal and inland port operations associated with the JDDSP and SCLA. This will be accomplished through electronically generated information reports that are integrated from the data provided by the SM21 ITS and the various operating systems within the SCLA and other systems that support freight movement through the SCLA. This information will be made available through the IP-MTOPS Web portal.

The IP-MTOPS will be used for the dissemination of actionable information to individual terminal personnel and for automating information collection, consolidation, and analysis efforts at the terminal and provided to internal and external SCLA-JDDSP customers. IP-MTOPS will be deployed using a network service oriented architecture designed to share information worldwide via Internet or private virtual networks. The IP-MTOPS Architecture will support the stepwise employment of XML and Web Service technologies designed to specifically support the SCLA-JDDSP Business Community of users.

The IP-MTOPS will be focused on supporting the functional management associated with controlling the inland port's (SCLA) physical operational flow of transportation assets, cargo and personnel. The IP-MTOPS must be capable of supporting the requirements of both military and commercial shippers. The system will not only support the throughput of shipments via a single mode but must also support modal diversions and shipment trans-loading operations for both import and export shipments.

5.1 Application Development Scenario

The application will be develop using a planned approach of incrementally introducing SM21 team members and other SCLA-JDDSP stakeholders to Web Services. SM21 could, acting on behalf of the SCLA local authority, establish the neutral, not-for-profit entity needed to establish and maintain a Private Universal Description, Discovery, and Integration (UDDI) Registry[11] for the SCLA-JDDSP Business Community (or Logistics Community of Practice (LCOP)). Further, SM21 will support the development of a secure environment to ensure secure document and data interchange. Figure 7 below, the SM21 OV 1B, provides an operational overview of the SCLA-JDDSP Business Community Service Infrastructure which creates the IP-MTOPS.

[11] The UDDI specification, currently maintained by OASIS, is not a specification for describing Web services – UDDI is simply used as the yellow pages of Web services.

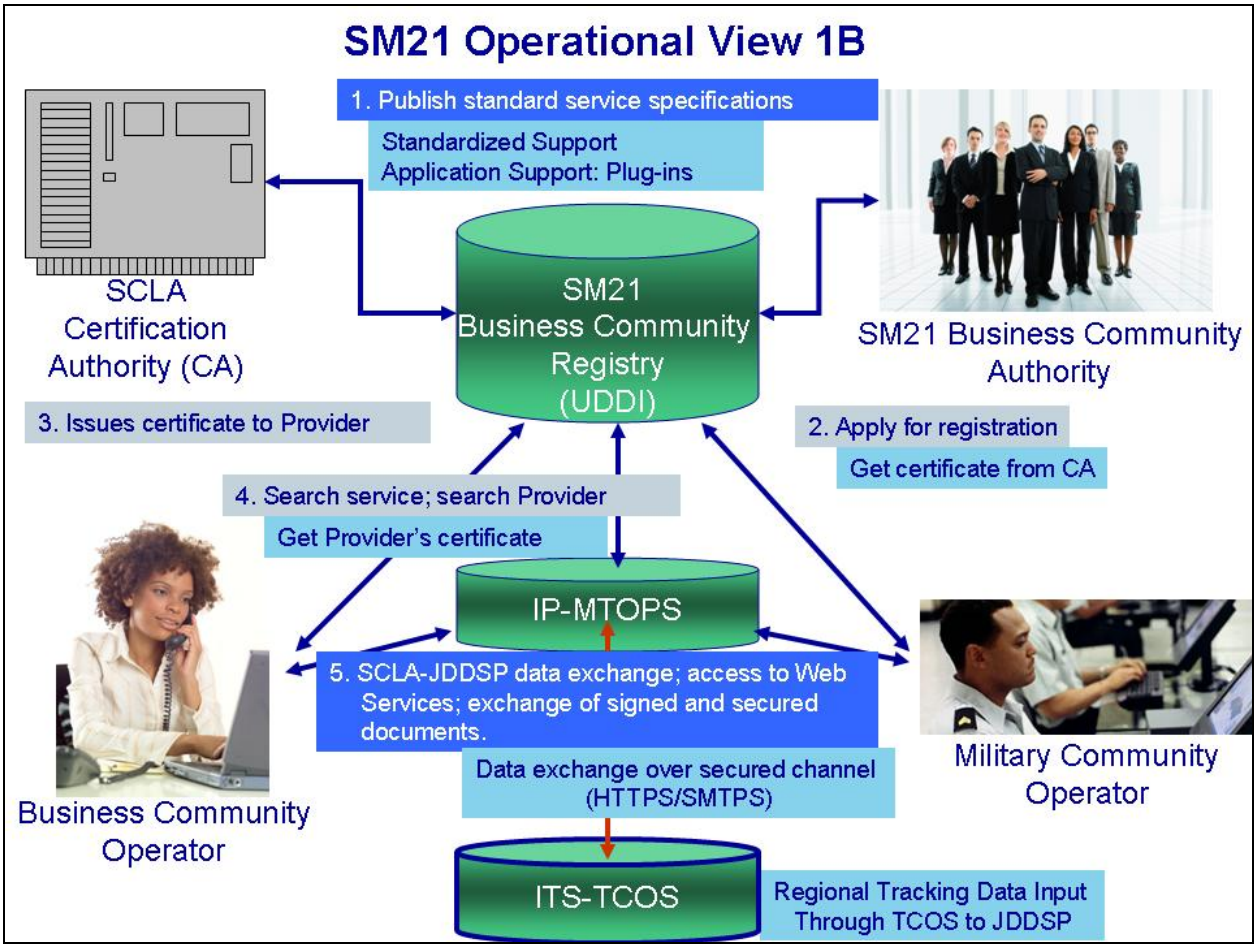


Figure 7: SM21 OV-1B - JDDSP Business Community Service Infrastructure

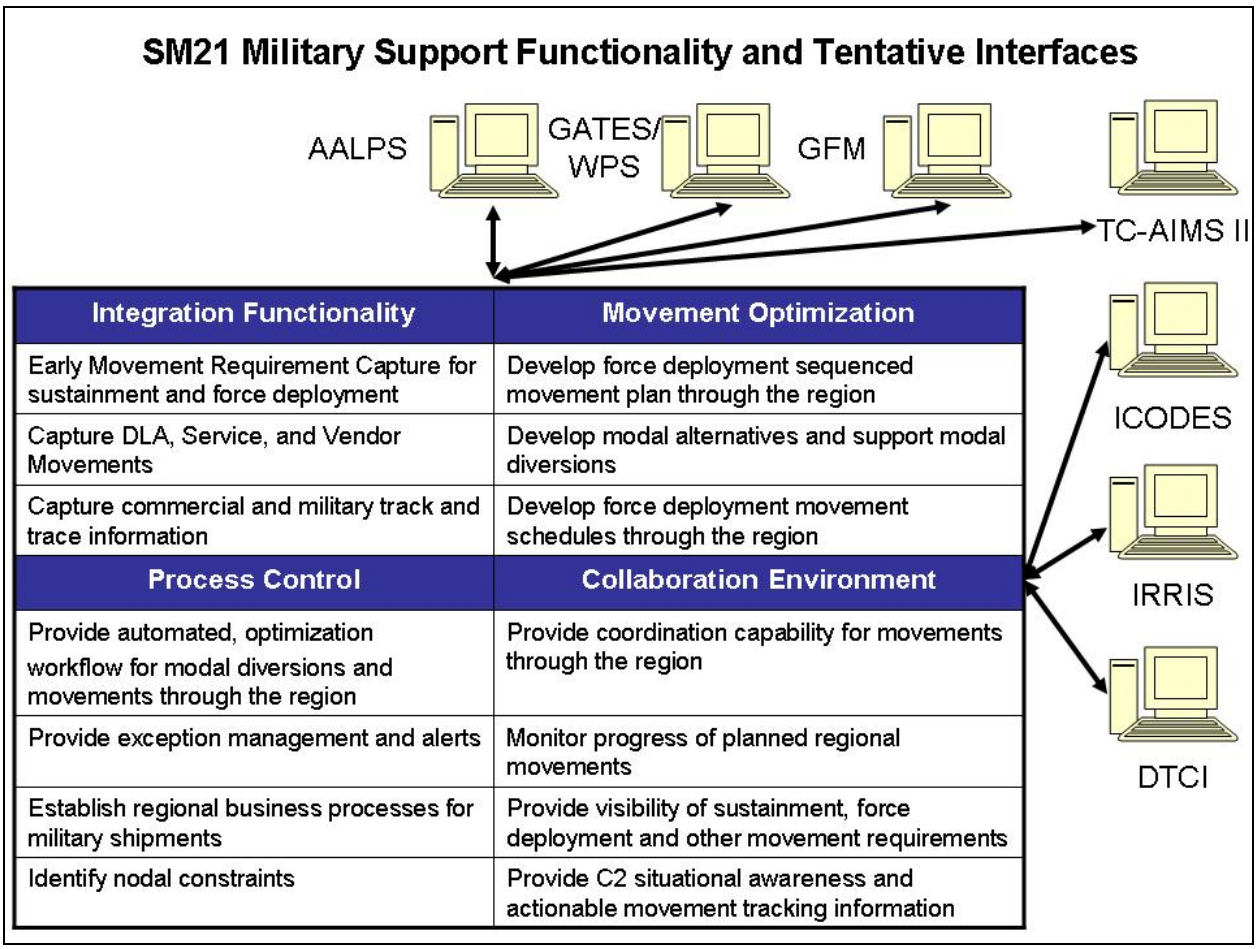
The initial use of the requirements defined in this specification will be to work with SCLA to identify the current and future facility tenant activities and map their intended operating systems against the requirements in this document and those established by the SM21 and SCLA enterprise architectures. The focus of this will be to begin planning both the "on-boarding" of the tenants' information systems (data integration with the IP-MTOPS and ultimately registration in the UDDI). Capability gaps will identified by matching the capabilities proposed within this document against the tenant capabilities. The gaps will be filled with the acquisition of additional commercial off-the-shelf software systems or through the development of Web services.

The IP-MTOPS application development is centered on interfaces that enable collaboration and the exploitation of structured and unstructured data by techniques such as data mining. As noted above, commercial off-the-shelf software such as intermodal operating systems and to some extent multi-modal operating systems already provide the capabilities to produce status interfaces and to manage the workflow at supported facilities. The IP-MTOPS will not duplicate the interfaces found in these commercial products. Instead, through the use of this specification and other SM21 requirement development work, the IP-MTOPS development will focus on identifying and filling requirement gaps.

As an example, SM21 identified a military capability gap between ship stow planning, ship load sequencing, and rail car load and movement planning for force deployments. Planning a surge deployment to minimize the impact on port operations, while decreasing deployment timelines, creates the requirement to sequence the arrival of rail cars so that equipment is delivered to a strategic port in the correct ship (deck and hold) loading sequence. One known gap is that there is no mechanism today to determine the order that equipment will be needed at the port to put it on to a ship to achieve a particular stow plan. This is done manually and in real time today, selecting equipment from the set of equipment available at the port. Today this often means moving the entire unit equipment set to the port and then loading potentially one piece at a time instead of loading the maximum number of decks and holds concurrently through all available ship entry points. There are other even more significant issues surrounding coordination with Class I railroads but at this point it is sufficient to say that the SCLA-JDDSP will be able to develop Web services to bridge this significant capability gap.

6.0 INTEGRATION REQUIREMENTS

The integration of both military and commercial systems is critical to the operation of the IP-MTOPS. The Figure 8 below provides a representation of the military systems requiring integration with the overall IP-MTOPS system. The System View 1 (SV-1) for military systems integration will also be supported by the commercial SV1, which will evolve more gradually over time. The initial commercial SV-1 will be developed at the beginning of the follow-on period of performance for the SM21 program.



Integration Functionality	Movement Optimization
Early Movement Requirement Capture for sustainment and force deployment	Develop force deployment sequenced movement plan through the region
Capture DLA, Service, and Vendor Movements	Develop modal alternatives and support modal diversions
Capture commercial and military track and trace information	Develop force deployment movement schedules through the region
Process Control	**Collaboration Environment**
Provide automated, optimization workflow for modal diversions and movements through the region	Provide coordination capability for movements through the region
Provide exception management and alerts	Monitor progress of planned regional movements
Establish regional business processes for military shipments	Provide visibility of sustainment, force deployment and other movement requirements
Identify nodal constraints	Provide C2 situational awareness and actionable movement tracking information

Figure 8: System View 1 - Military Interface Requirements

The specific military and commercial integration requirements are provided in the IP-MTOPS specification. It is however, important to note that the initial operating capability of the SM21 ITS must provide the ability to produce and consume transportation standard ANSI EDIx12 transaction sets in traditional flat-file and corresponding XML formats, including but not limited to:

104 Air Shipment Information
160 Transportation AEI
204 Motor Carrier Load Tender
110 Air Freight Details
163 Motor Appointment Schedule
214 Motor Carrier Shipment Status

216 Motor Carrier Shipment Pick-Up Notification
217 Motor Carrier Loading Guide
301 Ocean Confirmation
304 Ocean Shipping Instructions
309 Customs Manifest
310 Ocean Freight Receipt
315 Ocean Status
317 Delivery/Pick-Up Order
322 Terminal Operations Activity
323 Vessel Schedule
324 Vessel Stow Plan
350 Customs Status
404 Rail Shipment Information
410 Rail Freight Details
417 Rail Waybill Interchange
418 Rail Consist
423 Rail Switch List
440 Shipment Weights
810 Invoice
820 Payment Order Advice
824 Application Advice
856 Shipment Notice
858 Shipment Information
943 Warehouse Shipment Advice
944 Warehouse Receipt Advice
947 Warehouse Inventory Adjustment
996 File Transfer
997 Functional Acknowledgement

The following system information scenarios are provided as reference for the development of the SM21 ITS initial deployment and testing.

6.1 Ocean Import

- The Port and Terminal are pre-noticed of arriving inbound cargo via the vessel manifest. U.S. Customs provides Custom clearance status.
  Transaction sets:
  - Booking Information, EDI 301;
  - Vessel Manifest, EDI 309;
  - Bill of Lading, EDI 304;
  - Forwarding Instructions, EDI 304;
  - Customs Clearance Status, EDI 350;
  - Vessel Stowage Plan, EDI 324.
- The Port provides status updates as cargo is landed.
  Transaction sets:
  - Status Information EDI 304.
- For efficient handling (ramp, de-ramping) the Port unitizes/containerizes break-bulk cargo to suitable equipment.
- Automatic matching of arriving equipment and pre-advised information and system suggests terminal yard parking after equipment is identified based on:
  - Non-matching equipment marked for quarantined/ investigation;
  - Customs Hold/Release status;
  - Special Handling considerations (refrigerated, HAZMAT, etc.);
  - Pre-advised forwarding instructions;
  - Foreign Trade Zone (FTZ) Customs status.

  Transaction sets:
  - Terminal Operations Activity EDI 322.

6.2 Ocean Export

- Before the cargo can be accepted the shipment details is arranged between the exporting ocean carrier and shipper.
  Transaction sets:
  - Booking Information, EDI 301;
  - Bill of Lading, EDI 304;
  - Forwarding Instructions, EDI 304;
  - Customs Clearance Status, EDI 350;
  - Vessel Stowage Plan, EDI 324.
- Based on stowage plans, booking information and local yard situation, the Port plans the train loading sequence and sends that to the Terminal.
- Terminal system verify load ordering against:
  - Equipment and pre-advised information;
  - Customs hold/release status;
  - Special Handling considerations (refrigerated, HAZMAT, etc.).
- Terminal loads the train according to port ordering.
  Transaction sets:
  - Terminal Operations Activity, EDI 322.

6.3 Highway Arrival

- The Terminal is receives shipment information from the Consignor.
  Transaction sets:
  - Load Tender, EDI 204;
  - Transportation Status, EDI 214.
- Trucker presents himself and delivery documents at the gate.
- Documents are matched against system.
- Trucker is directed to parking area or unloading dock at terminal.
- Equipment/cargo is received.
  Transaction sets:
  - Terminal Operations Activity, EDI 322.
- Terminal sends arrival notice to related parties.

6.4 Highway Departure

- Terminal receives pickup instructions from the Consignee.
  Transaction sets:
  - Load Tender, EDI 204;
  - Response to a Load Tender, EDI 990;
  - Transportation Status, EDI 214.
- Trucker books pickup appointment (Web Interface or EDI).
- Trucker presents himself, delivery documents and pickup reference at the gate.
- Documents are matched against system.
- Equipment/ cargo is released.
  Transaction sets:
  - Terminal Operations Activity, EDI 322.

- Terminal sends release notice to related parties.

6.5 Inbound Rail

- The Terminal receives Shipment information from the Rail Carrier or Consignor.
  Transaction sets:
  - Bill of Lading, EDI 404;
  - Rail Waybill, EDI 417.
- The transport status and progress is reported via status messages.
  Transaction sets:
  - Terminal Operations Activity, EDI 322;
  - Car Location Message, NITL CLM.
- Rail Carrier delivers railcars to Terminal.
  Transaction sets:
  - Rail Consist, EDI 418.
- Arriving equipment is automatically matched against the pre-advised information.
- System suggests yard parking after equipment is identified based on:
  - Non-matching equipment is marked quarantined for investigation;
  - Customs hold/release status is recorded against equipment if export;
  - Special handling considerations (Refrigerated, HAZMAT, etc.);
  - Pre-advised forwarding instructions from Ocean Carrier.

  Transaction sets:
  - Terminal Operations Activity, EDI 322.
- Terminal sends arrival notice to related parties.

6.6 Outbound Rail

- Consignor (Terminal or Freight Agent) issues Shipment to Rail Carrier.
  Transaction sets:
  - Bill of Lading, EDI 404.
- Rail Carrier accepts shipment and generates a Rail Waybill.
  Transaction sets:
  - Rail Waybill, EDI 417.
- Terminal plans the train loading and generates work orders.
- Rail Carrier releases empty railcars Terminal.
- Terminal loads railcars.
  Transaction sets:
  - Terminal Operations Activity, EDI 322.
- Rail Carrier pulls railcars from Terminal.
  Transaction sets:
  - Rail Consist, EDI 418.

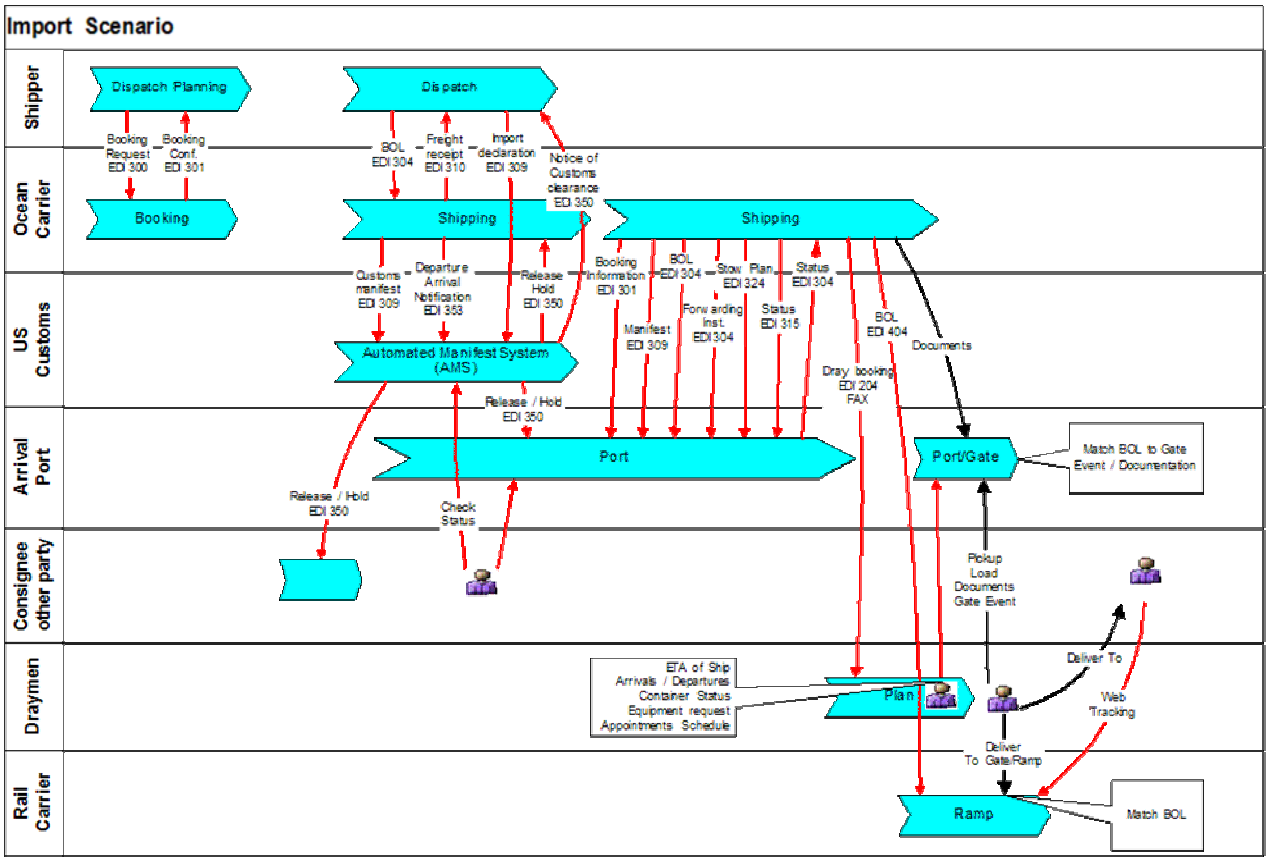


Figure 9: EDI Inbound to Port

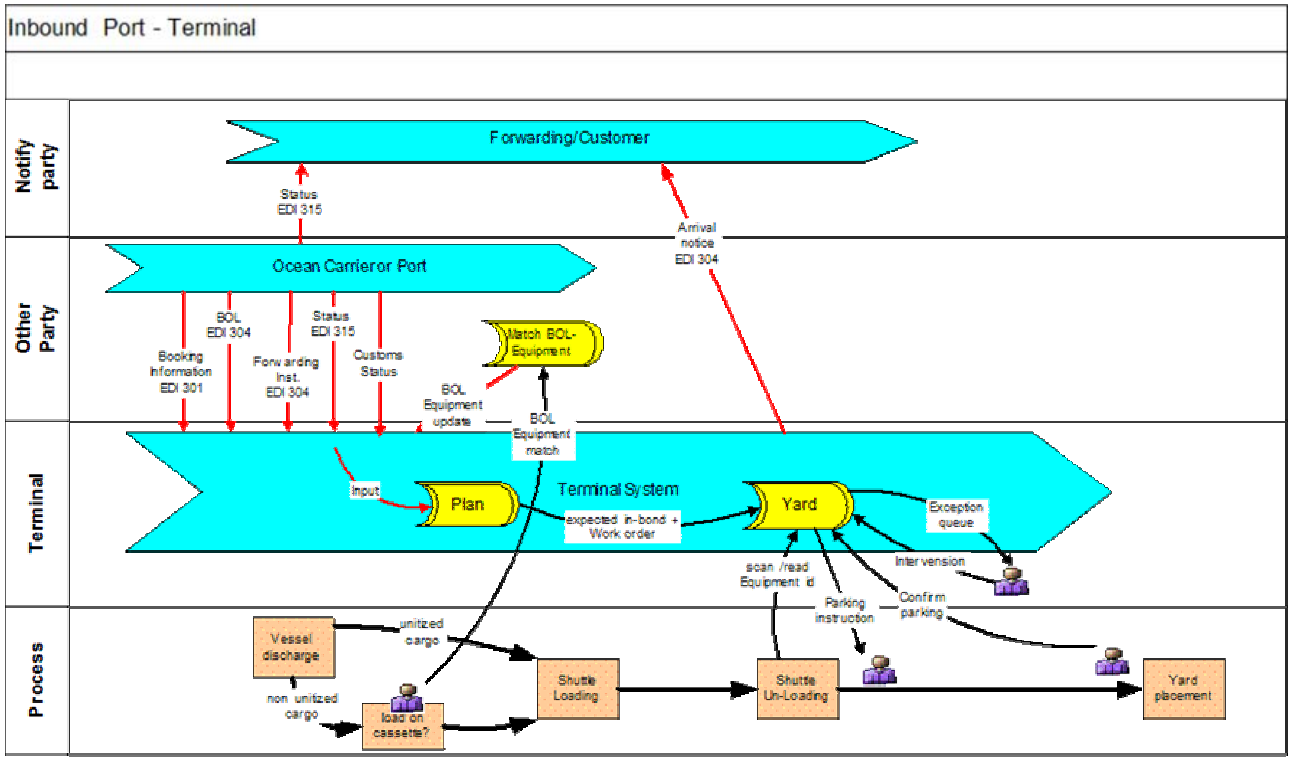


Figure 10: EDI Inbound to Terminal

7.0 CONCLUSION

This ITS design document identifies the technical and functional requirements for developing, procuring, and integrating components of a dual-use ITS capable of supporting an inland regional port, multi-modal operating software system. As intended, this document does not identify all the systems that will compose the end state deployment of the ITS or multi-modal operating system. However, this design document does support the initiation of the development, deployment, and testing of an ITS based on a Service Oriented Architecture (SOA). At the beginning of the next project year, the design established in this document will be developed and tested through a cooperative effort with Dole Foods, the fifth largest importer through the Ports of Long Beach and Los Angeles. SM21 will integrate the Dole Foods supply chain distribution network through Southern California. Together, SM21 and Dole Foods will conduct a number of experiments designed to support the testing and refinement of the ITS design. Additionally, the ITS design will support experimentation associated with military force deployment. Specifically, the ITS will support the pending force deployment demonstration associated with the CCDoTT Agile Port System.

The ITS, as designed to support of the JDDSP, will enable efficient dual-use node and individual terminal operations by supporting: the optimization of logistics flows; the maintenance of desired productivity; and the achievement of high service quality to strengthen customer relationships through up to the minute visibility of shipments and quick turn times.

APPENDIX A: GLOSSARY

Terminology	Definition
AAR	Association of American Railroads. The central coordinating and research agency of the American railway industry. This agency deals with matters of common concern in the whole field of railroading from operations to public relations.
ACCESSORIAL CHARGE	A service in addition to the line haul service, usually at an added expense. Charges incurred to provide additional services at the time of pick-up or delivery of the container. These might include driver assist in load or unload, driver waiting time to load or unload past free-time provision of the tariff, equipment rental (fork lift), blocking or bracing, additional stop-off charges, container charges etc.
ACL	Allowable Cargo Load. The amount of cargo and passengers, determined by weight, cubic displacement, and distance to be flown, that may be transported by specified aircraft.
ALL WATER SERVICE	(AWS) Ocean service from the Far East to the East Coast of the U.S. via the Panama Canal.
BACK HAUL	The movement of freight (or empty equipment) back to the point of origin in a lane of little or no demand for the service.
BAD ORDER	Something is wrong with the equipment.
BENEFICIAL OWNER	The entity that actual has title to the cargo being shipped.
BILL OF LADING	A document that establishes a contract between a shipper and a transportation company that moves freight between specified points for a specified charge. Usually prepared by the shipper on forms issued by the carrier, it serves as a document of title, a contract of carriage and a receipt for the goods.
BLOCKED TRAIN	Railcars grouped in a train by destination so that segments (blocks) can be uncoupled and routed to different destinations as the train moves through various junctions. Eliminates the need to break up a train and sort individual railcars at junctions.
BOC	Beneficial Owner of the Cargo. The entity that actually owns (has title to) the goods. See Beneficial Owner.
BOOKING	Recording arrangements for the movement of goods by ocean or stack train.
BRC	Billing Repair Card. A detailed record of repairs performed in accordance with AAR Rule 83.
BUNDLED RATES	Rates that include all costs in one charge.
CAPACITY PLANNING	A plan which measures and analyzes the ratio of units required versus units available for a given time period. The direct planning of specific units to specific loads.
CARRIER	An individual, company or corporation engaged in transporting goods.
CBP	U.S. Customs and Border Protection of the Department of Homeland Security.
CHASSIS	The wheels and frame assembly that supports the container.

CLAIM	A demand made upon a carrier for payment on account of loss sustained through its negligence or accidental damage while under the carrier's authority.
CLM	Car Location Movement. A railroad record movement of a load.
COFC	Container on flatcar. A container that moves on a flatcar without a chassis.
COMMODITY	The description of the actual goods being shipped.
COMMON CARRIER	A transportation company operating under a Certificate of Convenience and Necessity; provides service to the general public at published rates.
CONSIGNEE	The receiver of the goods being shipped.
CONSIGNOR	A person or company shown on the bill of lading as the shipper.
CONTAINER	A piece of equipment that has a removable chassis. Usually used in ocean carriage or on stack trains. Comes in various sizes: 20', 40', 45', 48' and 53'.
CONTAINER POOL	An agreement between parties that allows the efficient use and supply of containers. A common supply of containers available to the shipper as required.
CONVENTIONAL SERVICE	Containers moving on conventional flatcars (COFC/TOFC) owned by rail carriers.
CROSS-TOWN	A truck movement between one railroad intermodal ramp and another. Utilized either for speed or because the two railroads don't have a connection.
CUBE OUT	When a container has reached its volumetric capacity before it reaches its permitted weight limit.
CUT-OFF TIME	The latest time that a container may be delivered to a rail ramp or vessel in order to be accepted for the scheduled departure time.
CY	Container Yard. A place where chassis and container equipment is stored.
DEMURRAGE	See Per Diem
DERAMPED	A trailer/container that has been taken off a railcar.
DESTINATION	The place where the carrier releases the cargo to the consignee or his agent.
DETENTION	A charge by a vendor after a specific time has passed.
DISPATCH	Information given to the drayman that is picking up a load at origin or delivering it at destination.
DIVERSION	A change made in the route of a shipment in transit
DOOR-TO-DOOR	Through transportation of a container and its contents from consignor to consignee
DOUBLE STACK	Refers to placing one container on top of another container in a double stack railcar for onward movement.
DRAYAGE	The truck portion of an intermodal movement.
DRAYMAN	A carrier who provides pick-up and deliveries via truck to and from the rail yard.
DRIVER ASISST	When the driver is required to load or unload a shipment.
DROP	The driver leaves the trailer at the customer's facility and picks it up after it is loaded or unloaded.
DRY FREIGHT	Dry cargo not requiring temperature control protection

DST	Double Stack Train. Refers to the practice of placing one container on top of another in a special railcar for movement. See double stack.
EARLY WARNING	A directive issued by the AAR for interchange freight cars having mechanical or potential safety problems.
EDI	Electronic Data Interchange; The exchange of information via computer.
EIR	Equipment Interchange Receipt. A form used by parties delivering or receiving containers or container equipment. Used for equipment control and damage liability purposes. Synonymous with TIR (Trailer Interchange Receipt)
EMPTY REPO	Empty repositioning. The movement of empty containers by rail or truck to meet service requirements elsewhere.
EMPTY SLOT	An available loading position on a stack car created when a container isn't loaded to an available position. Also known as a vacant slot.
EN-ROUTE	In transit to destination.
ETA	Estimated Time of Arrival of a load.
FAK	Freight All Kinds; A generic term for any kind of freight.
FCL	Full Container Load
FEU	Forty-foot Equivalent Unit.
FLATCAR	A railcar, which a trailer/container is placed on to move via the railroad. A car without roof or walls.
FLIP	When a container is picked up off of the ground and mounted on a chassis for street or highway transport.
FRA	Federal Railroad Administration. The FRA deals specifically with transportation policy as it affects the nation's railroads and is responsible for enforcement of rail safety laws.
FREE TIME	The amount of time allowed by the carriers for the loading or unloading of freight before charges begin to accrue.
FREIGHT	Refers to either the cargo carried or the charges assessed for the carriage of the cargo.
FREIGHT BILL	A document issued by the carrier based on the bill of lading and other information; used to account for a shipment operationally, statistically, and financially.
FREIGHT FORWARDER	A company that arranges for the movement of import and export shipments. Also prepares all necessary U.S. Customs documentation.
FTZ	Foreign-Trade Zone. A restricted-access site, authorized by the FTZ Board and supervised by CBP (19 CFR 146) where companies can use special Customs procedures prior to entry for consumption. Zones are located in or adjacent to a CBP port of entry and operated pursuant to public utility principles under the sponsorship of a corporation granted authority by the Board pursuant to the Foreign-Trade Zones Act (19 USC 81a-81u) and regulations (15 CFR Part 400).
GATE	A point at an intermodal terminal where a clerk checks in and out all containers and trailer. All reservations and paperwork are checked at the gatehouse.
GENSET	Generator used to regulate temperature in a reefer container; can be run on its own power or plugs provided at the storage area.

GROSS WEIGHT	Combined weight of cargo and container ready for shipment.
HAZMAT	Hazardous Material. Product that is determined to be harmful and requires special handling as set forth by government agencies and the intermodal companies.
HOSTLER	An individual employed to move containers and trailers within a terminal or warehouse yard area.
IANA	Intermodal Association of North America. An industry trade association representing the combined interests of intermodal freight transportation companies.
ICC	Interstate Commerce Commission. A federal regulatory agency that governed over the rules and regulations of the railroading industry. The ICC Termination Act of 1995 ended this regulatory agency. Most responsibilities were transferred to the Surface Transportation Board.
IMC	Intermodal Marketing Company. An intermediary in the movement of intermodal shipments. See Third Party.
IN-BOND	A shipment that is moving but has not cleared U.S. Customs. The clearing of U.S. Customs will occur at destination.
INBOUND	Cargo moving from a rail terminal towards its destination. Generally used for cargo coming off a train and heading for final delivery to consignee.
IN-GATE	The transaction or interchange that occurs at the time a container is received by a rail terminal, container yard, or water terminal from another carrier.
INTERCHANGE	The exchange of railcars between connecting railroads.
INTERLINE	Between two or more transportation companies.
IPI	Inland Point Intermodal. A shipment booked and moved from foreign origin port to U.S. inland destination for one quoted charge by the steamship line.
ISO	International Organization for Standardization
J-1	A report filled out during the in-gate and out-gate process. The J-1 details damage to the unit, container information, shipping information, drayman involved and time of in-gate/ out-gate.
JOB CODE	A 4 digit number that identifies the inspection, repair, and/ or testing performed, or the car component applied or removed.
LADING	Refers to the freight shipped; the contents of a shipment.
LIFT	The process of moving a container or trailer to and or from a rail car.
LINE HAUL	The movement of freight via railroad from one city to another.
LIVE LOAD	The driver stays with a load while it is being loaded or unloaded.
LOCAL CARGO	Cargo that is booked from a foreign port to a U.S. port with no inland movement of the freight by the steamship line.
LTL	Less Than Truckload. A shipment that would not by itself fill the truck to capacity by weight or volume.
M&R	Maintenance and Repair. The process of maintaining equipment in good repair and serviceability.
MARINE TERMINAL	The facility where cargo is discharged from and loaded to the ocean vessel.

MHE	Materials-Handling Equipment. Mechanical devices for handling cargo.
NET WEIGHT	Weight of the cargo alone, without any immediate wrappings.
NOTIFY PARTY	The party that is notified at the time a container or trailer is grounded from a train. Most notify parties are draymen.
NVOCC	Non Vessel Operating Common Carrier. A company that buys wholesale space on steamship lines and resells the space to individual shippers at a profit.
OCP CARGO	Overland Common Point. Refers to cargo that is handled by the steamship line only to a U.S. port of entry. The shipper or consignee then plans to move the cargo inland (east of the Rockies) at their expense.
OD PAIR	Origin / destination locations identified in a tariff rate structure.
ON-DOCK	Refers to the process whereby cargo from the ocean vessel is loaded to railcars within the marine terminal.
ORIGIN	Location where shipment begins its movement at cargos expense.
OUTBOUND	Cargo moving from a shipper to rail ramp. Generally refers to cargo going onto a stack or conventional train.
OUT-GATE	The transaction or interchange that occurs at the time a container is delivered from a rail terminal, CY, or water terminal to another carrier.
OVER-THE-ROAD (OTR)	An all truck freight shipment, used in lieu of rail service, at a premium charge.
OWNER CODE (SCAC)	Standard Carrier Abbreviation Code identifying the carrier – drayman, steamship line etc.
PALLET	A wooden, paper or plastic platform usually with a top and bottom, on which packaged goods are placed to facilitate movement by some type of freight handling equipment.
PER DIEM	Additional charges to the shipper or consignee for a carrier's equipment past the free time provisions of the equipment interchange contract while the equipment remains in the possession of the shipper or consignee.
PICK-UP	The act of calling for freight by truck at the consignors shipping platform.
PICK-UP APPOINTMENT	Scheduled time for pick-up or loading of a container from a shipper or consignee.
PICK-UP NUMBER	A secure number provided to parties listed on the waybill. It allows only those parties to receive a container in order to out-gate from ramp facilities.
POD	Proof of Delivery. A form signed by the consignee, proving the load has been delivered.
POOL	A group of equipment at a customer's facility for them to load at their convenience.
PRENOTE	Information sent to the delivering carrier, telling where, when and how to deliver a load.
RAIL GROUNDING	The time that the container was discharged (grounded) from the train.
RAIL NOTIFICATION	Notification to the *Notify Party* that the container has been discharged from the train and is available for pick-up.

RAIL RAMP	The location where the draymen pick up and deliver loads to the railroad, and where trains are loaded or discharged.
RAMP	A technical rail ramp not serviced by an actual train.
RAMPED	A trailer/container that has been placed on a railcar.
REVENUE LOAD	A load of freight for which freight charges are applied.
REVENUE WAYBILL	A waybill showing the amount of charges due on a shipment.
RULE 11	A railroad accounting term which refers to a customer shipping their freight "pre-paid" to an intermediate point and "collect" beyond that intermediate point to the final destination.
SCAC	See Owner Code.
SEAL	Something applied to the outside of equipment doors after loading to assure the load has not been tampered with.
SERVICE FAILURE	When the actual delivery exceeds the customer's expectations by a specific amount of time.
SERVICE ORIENTED ARCHITECTURE	An architecture that relies on service-orientation as its fundamental design principle.
SHIPMENT	The tender of one lot of cargo at one time from one shipper at one location to one consignee at one destination, on one bill of lading.
SHIPPER	The actual party tendering a load of freight.
SHIPPING ORDER	Instructions of shipper to a carrier for forwarding of goods.
SHORING	A system of horizontal and/or inclined structural members fastened to the piles of a bent, group or row to increase stability by resisting or distributing lateral forces to the structure. Similar to bracing.
SLOT UTILIZATION	The method of utilizing every space available on a double stack car. A slot includes the space above a container when another container can be double-stacked. A five platform double stack car has 10 slots available for loading. If all 10 slots are loaded, you have 100% slot utilization.
SPOTTING	Placing a container where required to be loaded or unloaded
STACK CAR	An articulated five or three-platform railcar that allows containers to be double stacked.
STACK TRAIN	A dedicated train that hauls containers stacked two high.
STAY WITH	Type of drayman service whereby the driver remains with the freight while the shipper or consignee loads or unloads.
STCC	"Standard Transportation Commodity Code. A method of identifying products or commodities using standardized numeric codes.
STORAGE CHARGES	See Demurrage/ Per Diem.
SURCHARGE	An extra or additional charge.
TARE WEIGHT	The weight of packing material, or in railcar or container shipments, the weight of the empty railcar or empty container.
TARIFF	A publication setting forth the charges, rates and rules for transportation companies.

TENDER	The offer of goods for transportation or the offer to place cars or containers for loading or unloading.
TERMINAL	An assigned area in which containers are prepared for loading onto a train or are stored after discharge from a train.
TERMINAL CHARGE	A charge made for services performed in a carrier's terminal area.
TEU	Twenty-foot Equivalent Unit. A standard container size used for comparative measuring purposes. Normally applied to containers used by steamship lines (20, 40 and 45 foot containers)
THIRD PARTY	Refers to an intermediary, which arranges for the movement of intermodal shipments.
THIRD PARTY INTERNATIONAL	An ocean shipping company
TOFC	Trailer On Flat Car. A trailer that moves on a flat car with the chassis attached.
TRAILER	A freight vehicle equipped with a permanent wheel assembly and a device for attaching to a tractor for movement.
TRAILER INTERCHANGE	Transfer of a trailer and lading from one carrier to another.
TRAIN ID	A system to identify the trains origin and destination points, the day of the week for departure and the week of the year it moved.
TRANS PACIFIC	Import/export water service to and from the West Coast ports to and from Far East ports.
TRANSIT TIME	The actual amount of time for a load to move from point of origin to delivery at destination.
TRANSLOAD	The transferring of product from one piece of equipment to another.
UMLER	Universal Machine Language Equipment Register. A computer readable file of vital statistics for each railroad car in service. It applies to all railroads, types of cars, and data processing machines.
UNBUNDLED	A product that will have separate charges for each activity accorded to the shipment
UNIT TRAIN	A train of a specified number of railcars, which remain as a unit for a designated destination or until a change in routing is made.
WASTE CUBE	A container with empty space. May result when the weight load is reached before the volumetric limit.
WAYBILL	A document prepared by a transportation line at the point of a shipment; shows the point of origin, destination, route, consignor, consignee, description of shipment and amount charged for the transportation service. A waybill is forwarded with the shipment or sent by mail to the agent at the transfer point or waybill destination. Unlike a bill of lading, a waybill is not a document of title.
WHY MADE CODE	Numeric code used to designate the reason repairs or services were made or performed.
YARD	A classification, storage or switching area.

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